
Article:
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Abstract

Research on multiple health behaviours is increasing but little is known about parental behaviours and how they covary. Our study investigates cigarette smoking, alcohol intake, fruit and vegetable (F&V) consumption and physical activity among mothers and co-resident partners in England. Using the UK Household Longitudinal Study, we examined (i) clustering of health behaviours using observed-expected ratios and latent class analysis (ii) socio-demographic correlates of the derived latent classes and (iii) intra-couple concordance of individual health behaviours and their latent classes. We identified five latent classes for mothers and partners: Never smoked drinkers (28% of mothers; 29% of partners), Abstainers (25%; 17%), Drinkers and ex-smokers (19%; 26%), Unhealthy low frequency drinkers (18%; 16%) and Unhealthiest behaviour group (11%; 12%). These had distinctive social profiles. Never smoked drinkers were more likely than those in other groups to be white and socially advantaged: married, older, and with higher educational qualifications and incomes. Abstainers were non-smokers who never or occasionally drank, and were disproportionately drawn from ethnic minority groups and middle/lower income families. Drinkers and ex-smokers were the most physically active group and were more likely to be socially advantaged. Unhealthy low frequency drinkers were more likely to be disadvantaged and have a limiting long-standing illness. The Unhealthiest behaviour group had the highest proportion of smokers, heavy smokers and binge drinkers and the lowest F&V intake and physical activity levels. They were largely white and socially disadvantaged: younger, non-married and with lower educational levels. Mothers and their partners typically shared the same risk behaviours, and 44 per cent of partners and mothers belonged to the same latent class. Our findings point to the potential for a broadening of research and policy perspectives, from separate behaviours to combinations of behaviours, and from individuals to the domestic units and communities of which they are part.

Keywords	cigarette smoking; alcohol consumption; physical activity; diet; latent class analysis; social inequalities

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Suggested reviewers	Natasha Noble, Ruth Kipping, Hazel Inskip, Anne Ellaway

Submission Files Included in this PDF

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Dear editors

We thank the two reviewers for their positive, detailed and helpful comments on our paper.

We are pleased to submit our revised paper for consideration for publication in Social Science and Medicine – Population. We confirm that it has not been submitted elsewhere.

We attach our response together with the revised paper and revised associated documents.

We look forward to hearing from you

Yours sincerely

Hilary Graham

Ethical statement

The paper is based on secondary analysis of data that was subject to ethical review at the point of collection. The dataset was accessed via a signed End User Licence.

We thank the reviewers for their positive and helpful comments on our paper. Our responses to each point are given in italics below.

Comments from the editors and reviewers:
-Reviewer 1

- The work, exploring the clustering patterns of risky healthy behaviours is quite innovative and definitely will add new knowledge to the existing evidence.

I have few points for authors to be clarified.

1. UKHLS
The study sample of UKHLS was collected from the UK, yet authors claimed that results are based on England. It will be helpful for readers to know why authors limited their sample to one country.

The focus on England rather than the UK is already explained in the paper (see final para of the Introduction section). We state:

> ***In the UK context, England's public health policy gives a particularly strong emphasis on health behaviours (Graham, 2009; Smith & Collin, 2013); additionally, the study funders focus on public health in England.***

In response to the reviewer's comment, we have strengthened this statement further:

> ***Our focus on England reflects the devolved structure of policy-making and government in the UK. Within this devolved structure, England's health policy has a particularly strong emphasis on health behaviours (Graham, 2009; Smith & Collin, 2013) and the study funder's remit is to provide evidence to inform this policy.***

2. Health behaviours
I understand that information collected on health-related behaviours were limited, especially alcohol use. Authors showed that alcohol use was for participants' alcohol consumption on a day when they used most (for each alcohol beverage). It means the response only reflects the existence of binge-like drinking patterns (not even the frequencies of such usage).

We recognise the reviewer's concerns and have therefore added the following to the Discussion section's consideration of study limitations (new text underlined):

> ***The UKHLS included a restricted range of health behaviour questions from which to derive proxies for current (2010/11) recommendations (Box 1). <u>For alcohol consumption, our focus was restricted to binge drinking in the previous week; we were unable to consider government guidelines on weekly consumption</u>. It should also be noted that the binge drinking recommendation has been revised by the UK government; in 2016, the threshold for men was lowered to match the one for women (Department of Health, 2016).***

Responses do not produce weekly/daily alcohol consumption, therefore it is wrong to state participants' alcohol usage as average (page 4, abstainers). Because of this limitation (unable to ascertain weekly/daily consumption), authors could not claim that participants' alcohol use is 'within' limit, either.

In the submitted paper, we did not state whether alcohol usage was average, or whether it was within all government guidelines. We were clear that we were assessing drinking risks in relation to single occasion intake and governments guidelines on binge drinking.

Also authors focused on 'current' behaviours, apart from smoking which they included the previous usage as well as current one. They need to clarify why 'past' usage could be considered as 'risky' in terms of the duration of regular use and the timing of quitting cigarettes.

We included responses about age of smoking initiation to determine the latent classes because early age of smoking initiation is associated with difficulty quitting and longer term use, as well as with heavier smoking. This point has now been added to the method section.

3. Statistical approach/results
Authors could discuss a bit more with the justification on numbers of clusters in terms of fit indices.

We attached particular importance to the interpretability of the resulting classes when determining the final number of classes. This point has been added to the methods section. We also note that more information is provided in the Appendix and we refer readers to the relevant section of the Appendix.

Also authors used step-wise logistic regression to identify socio-demographic characters that are associated with clustering health-related behaviours.
There is plenty evidence linking income, employment status, occupational position, gender, age, and age of youngest children with health-related behaviours.
Authors could have used a theoretical approach to identify which variables to be most useful for the model.

A theoretical approach was used to reduce the large number of variables that could have been included in the models before employing step-wise logistic regression to avoid over adjustment of the remaining covariates. We included socio-demographic factors that, as the reviewer notes, have been found to predict health behaviours. We now note and reference this in our methods section (sub-section on analysis techniques).

I am for one would like to see this work to be published. Good luck.

-Reviewer 2

- Overall I consider this work to be a valuable contribution to the field of multiple behaviour research. Below I highlight some observations that I feel need to be considered prior to publication. I hope the authors find these comments useful.

1) The authors use two approaches to investigate clustering (latent class analysis and prevalence odds ratios). It would be useful to know why the investigators chose to explore clustering using both approaches, rather than choosing one of them. I think the authors should also discuss which approach they consider to be superior.

We included observed-expected ratios as these are widely used and understood within the public health research and policy community. We therefore consider it helpful to provide these analyses before presenting analyses based on LCA.

The Introduction to the paper discusses the enhancements that LCA brings to an analysis of multiple risk behaviour. But we agree that our view of its superiority could be more clearly conveyed. We have revised the relevant paragraph to do this (new/revised text underlined):

> ***Recent reviews have identified two main analytical approaches: examining differences between observed and expected combinations of behaviour and interrogating underlying patterns across the behaviours (McAloney et al., 2014; N.Noble et al., 2015). <u>The first approach led the way in the analysis of multiple risk behaviours (McAloney et al., 2014). It uses dichotomous measures of behaviours and observed and expected (O/E) ratios to provide a simple summary measure of whether combinations of behaviours occur more (or less) often than would be expected if the behaviours were independent. Relying on more advanced statistical techniques, the second approach offers a number of analytic advantages</u>…***

2) The sample of mothers was restricted to those who were not pregnant. Whilst I understand mothers behaviours are likely to be different during pregnancy I think it is important to state how many pregnant mothers were excluded and discuss in the limitations section how this may lead to some bias in the sample (I would think that this will disproportionately affect younger mothers whom may have one young child and be pregnant with their second child)?

Only 3.3% (124) of partnered mothers were excluded because they were pregnant. This information has been added to the methods section. We do not consider that the small number would lead to bias in the sample; we therefore do not discuss it further.

3) The authors provide some information on missing data management (in relation to alcohol consumption amongst ethnic minorities). However, it appears that the analysis is conducted on those with information for all health behaviours and socio-demographic information.

Would the authors be able to state why they restricted their samples to those with complete information rather than using missing data techniques such as multiple imputation or maximum likelihood?

We did this because, in both in our study and in other studies, the majority of those from minority ethnic groups who did answer the alcohol consumption questions reported no alcohol intake. We therefore decided a simple imputation approach was justified. The proportion of missing data on other variables was low.

Furthermore, on page 2 paragraph 6 the authors direct the reader to "see appendix" to learn more about the imputation for missing data on alcohol consumption - this instruction needs to be more specific (i.e. number each appendix/provide page number).

We have now numbered the sections of the Appendix (A1, A2 etc.) and refer readers to the relevant section.

I do not think it is clear how many people were removed by considering only complete cases - it would be useful to see a flowchart of how the samples were selected and explicitly state how many people were removed.

A chart is provided in the Appendix (section A1)

4) The authors state (on page 3 1st paragraph under analysis technique) that all of the LCA results correspond to weighted estimates. However, I have read previously in a paper by Conry at al (Conry, 2011) that weighting is not recommended in cluster analysis. Whilst I understand that the hierarchical cluster models used by Conry differ from the LCA models used here it would be useful to know why the authors here consider it appropriate whereas Conry (2011) did not?

It is correct to use weights (and adjust for complex survey design) in LCAs if the results are to be generalised to the population, as here, rather than simply to the sample. Our approach is therefore appropriate. (see Muthén and Muthén)

In the same section (page 3 2nd and 3rd paragraphs) the authors refer to unweighted sample sizes, I am unsure why unweighted sample sizes have been provided given that the analysis is undertaken on weighted samples.

We include unweighted numbers to provide background information; it is contextual information that some readers prefer to see.

5) It would be useful to see the AIC and BIC estimates for each LCA model as well as the global entropy for the 5 class model.

The graphs of AIC and BIC estimates across LCA solutions ranging from 2 to 8 classes have now been included in the supplementary materials (section A4). While we did not record global entropy results, we do report misclassification. This is assessing a similar issue i.e. how well individuals are allocated to a particular class.

6) From what I can gather the analysis of socio-demographic correlates of each LCA class was undertaken following the modal of assignment of individuals (based on most likely latent class). I think the authors should be more explicit why they chose to modally assign individuals (and mention the limitations of this approach - as outline by Heron et al (Heron, 2015)) and whether this analysis was also conducted in latent gold or another software?

We used latentGOLD software as noted in the Methods section of the submitted manuscript.

We assigned individuals to the most likely class (Clark and Muthén 2009). As we discuss below, there are downsides as well as advantages to incorporating covariates in the LCA model and in two-step procedures Clark and Muthén show that most likely class membership performs better than other approaches.

Furthermore, it would be useful if the authors could briefly state why they included covariates in the analysis after identifying the optimal measurement model (rather than the LCA model selection process being undertaken on models that include the covariate).

Conceptually, our approach is in line with the wider field of health behaviour research: to identify patterns of single/multiple behaviours before investigating their social predictors. It is also one that aids policy interpretation, a particular challenge for studies based on more advanced statistical methods like LCA.

Methodologically, we recognise that there are different approaches to the inclusion of covariates in LCA. We have added this point to the discussion. While there is now more discussion of the benefits of inclusion of covariates in the LCA estimation, particularly in relation to precision of standard errors, there are also downsides. These include the fact that the covariates may potentially influence the formation and interpretation of the latent classes. Since we were estimating latent classes for mothers and partners and were interested in the comparability of the classes themselves, this was likely to be especially problematic. Our approach - allocating observations to 'most likely' class and then regressing the latent classes on the covariates of interest - remains the most commonly used approach in the literature where the determinants of discrete latent classes is the question of interest.

7) On page 4 under the heading "multiple health behaviours: identifying latent classes" the authors state that the classes were similar for mothers and partners. Whilst this does seem to be the case on examination of the model estimates it would be useful to know whether any formal tests for measurement invariance were conducted to strengthen this assumption (i.e. using multiple group LCA models)?

As the reviewer notes and we state in the paper, the classes identified for partners are similar to those identified for mothers: a 5-class solution was optimal in both cases and these solutions were very similar for both mothers and partners. No formal test for measurement invariance was conducted.

8) On page 7 paragraph 4 the authors explain the socio-demographics of members of the 'never smoking and frequent drinking' and 'never smoking and never drinking' classes. In terms of public health implications would the authors suggest which class is considered more beneficial for health? Or do they consider them equally health damaging?

The aim of our study is to describe clusters of health behaviours rather than to 'rank' them in terms of their health benefits and risks. We would also have concerns about such an exercise. For example, for the two clusters to which the reviewer refers, "Never Smoked drinkers" exhibited both healthy (not smoking, relatively high levels of physical activity) and unhealthy (some binge drinking) behaviours. The same could be said of the Abstainers who had some healthy (not smoking, occasional or non-drinking) and unhealthy (below average physical activity) behaviours. Furthermore, as reviewer 1 notes,

we cannot assess whether the amount of alcohol consumed over a week is within government recommendations.

Moreover, I think it would be useful for the authors to propose mechanisms through which these socio-demographics influence health behaviour (i.e. income and education) based on empirical evidence. This would allow more specific examples of how policies "addressing the wider determinants" (page 9, paragraph 2) can improve health behaviours.

We consider we have taken the discussion of the paper's findings as far as our analyses allow. As noted above, the analysis is cross-sectional; we would therefore be wary about extending our Discussion and Conclusion by speculating on mechanisms that underlie associations between social position (e.g. income and education) and multiple health behaviours. In the Conclusion, we do however discuss how findings could inform public health policies, particularly with respect to policies framed by social determinants of health approaches, and give specific policy examples.

9) The first paragraph on page 8 states that the largest group of couple combinations was 'never-smoked drinkers'. Looking at the results it also seems a large proportion of non-smoking drinking mothers and ex-smoking drinking partners couple together - this could be explored further in the discussion? (Are men quitting smoking when they are in a cohabiting relationship?)

Because the analyses were cross-sectional (rather than longitudinal), we were unable to determine whether an individual's health behaviours change in response to the health behaviours of their partner. This point has now been added to the discussion.

References:

Conry MC, Morgan K, Curry P, McGee H, Harrington J, Ward M, et al. The clustering of health behaviours in Ireland and their relationship with mental health, self-rated health and quality of life. BMC public health. 2011;11(1):692. DOI: http://dx.doi.org/10.1186/1471-2458-11-692.

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Clark, S. & Muthén, B. (2009). Relating latent class analysis results to variables not included in the analysis. https://www.statmodel.com/download/relatinglca.pdf

Muthén, L.K. and Muthén, B.O. (1998-2015). *Mplus User's Guide*. Seventh Edition. Los Angeles, CA: Muthén & Muthén

Note: new text is in grey shading; deleted text is track-changed in red

MULTIPLE HEALTH BEHAVIOURS AMONG MOTHERS AND PARTNERS IN ENGLAND: CLUSTERING, SOCIAL PATTERNING AND INTRA-COUPLE CONCORDANCE

ABSTRACT

Research on multiple health behaviours is increasing but little is known about parental behaviours and how they covary. Our study investigates cigarette smoking, alcohol intake, fruit and vegetable (F&V) consumption and physical activity among mothers and co-resident partners in England. Using the UK Household Longitudinal Study, we examined (i) clustering of health behaviours using observed-expected ratios and latent class analysis (ii) socio-demographic correlates of the derived latent classes and (iii) intra-couple concordance of individual health behaviours and their latent classes. We identified five latent classes for mothers and partners: Never smoked drinkers (28% of mothers; 29% of partners), Abstainers (25%; 17%), Drinkers and ex-smokers (19%; 26%), Unhealthy low frequency drinkers (18%; 16%) and Unhealthiest behaviour group (11%; 12%). These had distinctive social profiles. Never smoked drinkers were more likely than those in other groups to be white and socially advantaged: married, older, and with higher educational qualifications and incomes. Abstainers were non-smokers who never or occasionally drank, and were disproportionately drawn from ethnic minority groups and middle/lower income families. Drinkers and ex-smokers were the most physically active group and were more likely to be socially advantaged. Unhealthy low frequency drinkers were more likely to be disadvantaged and have a limiting long-standing illness. The Unhealthiest behaviour group had the highest proportion of smokers, heavy smokers and binge drinkers and the lowest F&V intake and physical activity levels. They were largely white and socially disadvantaged: younger, non-married and with lower educational levels. Mothers and their partners typically shared the same risk behaviours, and 44 per cent of partners and mothers belonged to the same latent class. Our findings point to the potential for a broadening of research and policy perspectives, from separate behaviours to combinations of behaviours, and from individuals to the domestic units and communities of which they are part.

INTRODUCTION

Four behaviours – cigarette smoking, high alcohol intake, poor diet and physical inactivity – underlie the chronic diseases (cardiovascular disease, cancer, lung disease and type-2 diabetes) responsible for 70% of premature deaths in Europe (WHO, 2011, 2014). These behaviours have both separate and synergistic effects on health (Khaw et al., 2008; Kvaavik, Batty, Ursin, Huxley, & Gale, 2010; Martin-Diener et al., 2014; WHO, 2008). Social disadvantage increases the risk of smoking, poor diet and physical inactivity; evidence for high alcohol intake is less consistent (Bloomfield, Grittner, Kramer, & Gmel, 2006; Stringhini, Sabia, Shipley, & et al., 2010). The four behaviours are a major focus of public health policies, with governments advising the public not to smoke and providing recommendations on minimum levels of physical activity and fruit and vegetables intake (F&V) and maximum thresholds for alcohol consumption.[1]

While much of the evidence focuses on single health behaviours, there is increasing appreciation that these behaviours are not independent (McAloney et al., 2014; Noble, Paul, Turon, & Oldmeadow, 2015; Prochaska, Spring, & Nigg, 2008). Earlier studies have investigated the co-occurrence of behaviours by establishing the prevalence of different risk behaviour combinations and/or by summing the number of risk behaviours reported by each study participant into a risk score. However, these approaches have limitations (McAloney et al., 2014; N. Noble et al., 2015). Establishing that behaviours co-occur does not establish whether their co-occurrence differs from what would be expected given the prevalence of each behaviour, and risk scores do not indicate which behaviours contribute to an individual's score.

Studies are therefore increasingly going beyond co-occurrence and risk scores to examine inter-relationships between health behaviours. Recent reviews have identified two main analytical approaches: examining differences between observed and expected combinations of behaviour and interrogating underlying patterns across the behaviours (McAloney et al., 2014; N.Noble et al., 2015). The first approach led the way in the analysis of multiple risk behaviours (McAloney et al., 2014). It uses dichotomous measures of behaviours and observed and expected (O/E) ratios to provide a simple summary measure of whether combinations of behaviours occurs more (or less) often than would be expected if the behaviours were independent.

Relying on more advanced statistical techniques, the second approach offers a number of analytic advantages. It moves beyond observed combinations of behaviour, to identify latent (or unobservable) types either of participants based on their behaviours (e.g. latent class analysis) or of behaviours (e.g. factor analysis) (Hofstetter, Dusseldorp, van Empelen, & Paulussen, 2014). Latent class analysis (LCA) is increasingly used to investigate inter-relationships between behaviours (Mawditt, Sacker, Britton, Kelly, & Cable, 2016; McAloney et al., 2014; N. Noble et al., 2015). It identifies mutually exclusive behavioural clusters to which study participants are assigned on the basis of their probability of membership. While some studies use single dichotomous measures of behaviour based on adherence to national public health guidelines (e.g. (de Vries et al., 2008), the

[1] Examples include Australia (e.g. physical activity: http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-strateg-phys-act-guidelines#apaadult; diet http://www.eatforhealth.gov.au/guidelines/australian-guide-healthy-eating; alcohol intake http://www.alcohol.gov.au/internet/alcohol/publishing.nsf/Content/guide-adult), USA (physical activity http://health.gov/paguidelines/pdf/paguide.pdf; diet http://health.gov/dietaryguidelines/2015/guidelines/; alcohol intake http://health.gov/dietaryguidelines/2015/guidelines/appendix-9/ and smoking http://smokefree.gov/); DoH, 2003, 2005, 2011, 2013a, 2013b

methods allow a broader set of measures of the relevant behaviours to be included, for example, smoker/ex-smoker/never smoker. In addition, by identifying underlying relationships between behaviours, a potentially large number of behavioural combinations can be reduced to a smaller number of behavioural classes (McAloney et al., 2014; Muthén, 2001). The socio-demographic profile of the resultant classes can also be described, for example by regression analyses to predict class membership (Cleveland, Collins, Lanza, Greenberg, & Feinberg, 2010; Evans-Polce, Lanza, & Maggs, 2016; Robinson, 2012).

However, while evidence on multiple risk behaviours is accumulating, there are important gaps. Despite the policy emphasis on settings-based approaches to health promotion (Poland, Krupa, & McCall, 2009; WHO, 2013), we found no studies investigating intra-household associations in multiple risk behaviours. In addition, most studies focus on the general population, together with a few studies of younger adults, older people and patient populations (e.g. people with hypertension, cancer survivors) (King et al., 2015; McAloney et al., 2014; N. Noble et al., 2015). Neither of the reviews of multiple health behaviours studies included studies of parents or reported measures that enabled identification of parents, e.g. presence of dependent children in the household (King et al., 2015; McAloney et al., 2014; N. Noble et al., 2015). A citation search of the reviews identified a further five studies of clustering of the four behaviours covered here (Bryant, Bonevski, Paul, & Lecathelinais, 2013; Filippidis, Agaku, & Vardavas, 2015; Kritsotakis, Psarrou, Vassilaki, Androulaki, & Philalithis, 2016; Mawditt et al., 2016; Morris, D'Este, Sargent-Cox, & Anstey, 2016). Again, none provided information on parental health behaviours.

As this suggests, little is known about parental health behaviours and how they covary. Yet parents caring for dependent children represent a large sub-group of the population. In the UK, they represent 31% of all adults (Office of National Statistics (ONS 2014). Over a third of UK married couples (38%) and cohabiting couples (41%) are caring for dependent children in the family, and 75% of children are living in two-parent households (ONS, 2015). Childhood and adolescence are formative periods for the development of health behaviours which persist into adulthood (Ebrahim, Montaner, & Lawlor, 2004; Jefferis, Power, Graham, & Manor, 2004; Schooling & Kuh, 2002) and parents are an important influence on the behaviours of their children (Brown & Ogden, 2004; Edwardson & Gorely, 2010; Gilman et al., 2009; Pearson, Biddle, & Gorely, 2009; Van Der Vorst, Engels, Meeus, Deković, & Van Leeuwe, 2005).

Our study investigates patterns of smoking, alcohol intake, F&V consumption and physical inactivity among co-resident parents caring for dependent children in England. Within this devolved structure, England's health policy has a particularly strong emphasis on health behaviours (Graham, 2009; Smith & Collin, 2013) and the study funder's remit is to provide evidence to inform this policy. ~~the UK context, England's public health policy gives a particularly strong emphasis on health behaviours (Graham, 2009; Smith & Collin, 2013); additionally, the study funders focus on public health in England.~~ We include measures based on government recommendations ('health risk behaviours') along with a fuller range of measures of the four behaviours. Looking separately at mothers and partners, we examine (i) inter-relationships between heath behaviours using observed-expected ratios and LCA and (ii) the socio-demographic correlates of the latent classes. Focusing on mother-partner pairs, we examine (iii) intra-couple concordance of health risk behaviours and class membership. Because 'class' is commonly used to refer to an individual's socioeconomic background, we use 'group' and 'latent class' when referring to the classes derived from the LCA.

DESIGN AND METHODS

The study population: The UK Household Longitudinal Study (UKHLS) is a panel study of individuals from c28,000 UK households and an ethnic minority boost sample of around 4,000 households. Study participants were first surveyed in 2009/10 and are followed up each year (Buck & McFall, 2011; ISER & NatCen Social Research, 2012). In 2010/11 (wave 2), the UKHLS included questions on the four health behaviours.

We defined mothers as adult non-pregnant women (aged 16 years and over) who lived in England and had a child <16 years living with them at the time of the interview whom they reported to be their natural, step, foster, or adoptive child. A small proportion (3.3%) of mothers was excluded because they were pregnant. Partners were the co-resident partners of mothers. Almost all (99.6%) of the partners were male and most (78%) were married to the mother. Further sample details are given in supplementary appendix A1.

Questions on health behaviour: The main interview included questions on smoking, F&V consumption and physical activity; alcohol consumption was part of a separate self-completion questionnaire (details in supplementary Appendix A2). A high proportion of responses were missing for alcohol consumption among minority ethnic groups; imputed values were therefore derived from median values matched for ethnic and religious group, marital status and country of birth (see appendix).

Behavioural measures included ones aligned to government recommendations for smoking, single-occasion alcohol intake (consuming more than twice the recommended daily limit, with separate limits set for men and women) and F&V consumption; for physical activity, we derived a measure that approximated to the recommendation (see Box 1). These binary measures (meeting/not meeting the relevant recommendation) were used for investigating clustering using observed-expected ratios; for the LCA, additional categories and a wider range of behaviour measures were used (see Box 2). In addition to current smoking behaviour, age of smoking initiation was used in the LCAs because early smoking initiation is associated with difficulty quitting and longer term use, as well as with heavier smoking (Breslau et al, .1993; Lando et al, 1999).

Box 1 and box 2 about here

Analysis techniques: Analyses were conducted in Stata with the exception of the LCA which was conducted using latentGOLD software version 4.5 (Vermunt & Magidson, 2008). Adjustments were made for the survey's complex survey design and differential non-response (Knies, 2014); all results refer to weighted estimates (further details on weighting are given in Appendix A3).

With the exception of intra-couple concordance, analyses were conducted separately for mothers and partners. Clustering was investigated using both O/E ratios and LCA. Analyses based on O/E ratios included mothers and their partners with data (self-reported responses or imputed values) for the four behaviours (mothers: unweighted n=2538; partners: unweighted n=2538). O/E ratios were calculated for each risk behaviour combination, for example not meeting recommendations for F&V and physical activity but meeting the smoking and alcohol intake recommendations. Values >1 and <1 indicated clustering; statistical significance was based on 95% confidence intervals.

The LCA included respondents with data for the full range of behavioural measures (Box 2) (mothers: unweighted n=3397; partners: unweighted n=2554). All mothers and partners who answered the behaviour questions were included. With no definitive method of determining the optimal number of classes, we considered measures of fit (Akaike's Information Criterion and the Bayesian Information Criterion), the misclassification rate, the percentage of cases in each class with a low probability of class membership, class stability across successive class solutions and the interpretability of the resulting classes (Nylund, Asparouhov, & Muthén, 2007; Weich et al., 2011). Further information is provided in the supplementary Appendix A4. We attached particular importance to the interpretability of the resulting classes when determining the final number of classes. Individuals were allocated to a class on the basis of their probability of membership (Clark and Muthén, 2009) ~~Individuals were allocated to a class on the basis of their probability of membership.~~

The socio-demographic correlates of each LCA class were determined using stepwise logistic regression, with class membership as the dependent variable and socio-demographic factors as predictors (details in appendix). We included socio-demographic factors predictive of multiple health behaviours among adults (Conry et al, 2011; N.Noble et al., 2015; Poortinga, 2007), together with those reported in studies of parental health beheaviours (Bartley et al, 2004; Robinson et al, 2004; Schoon and Parsons, 2003). We included: age, domestic relationships (marital status, number of children, age of youngest child), socioeconomic circumstances (education, household income), employment status, ethnic background and health status (limiting long-standing illness). The social profile of each class was determined by producing predicted probabilities of belonging to a class for socio-demographic factors that remained significant predictors in regression models. The small number of black African and Arabs were combined with Indian, Pakistani and Bangladeshi groups; the majority of this combined group were from South Asia.

Analyses of intra-couple concordance included couples where both mother and partner had data for the relevant behavioural measures: 2538 couples for concordance in the couple's risk behaviours and 2361 couples for concordance in their latent classes. Logistic regression was used to determine significant associations between mothers' and partners' latent classes.

RESULTS

i) Multiple health risk behaviours: prevalence and clustering using O/E ratios

The majority of mothers and partners did not meet the recommendations for F&V consumption (mothers: 80%; partners: 86%) and physical activity (77%; 72%). A larger proportion of partners (32%) than mothers (22%) reported alcohol intakes in the previous seven days that exceeded binge drinking thresholds; a larger proportion of partners (24%) than mothers (19%) were also smokers. Partners had more risk behaviours than mothers: 78% had two or more risk behaviours compared to 74% of mothers. A smaller proportion of partners than mothers (3% vs 5%) reported no risk behaviours and a higher proportion (7% vs 4%) reported all four risk behaviours.

The most commonly-occurring combination of risk behaviours was not meeting the recommended levels of F&V consumption and physical activity. However, there was no evidence of clustering. Clustering was apparent for having all four, and having no risk behaviours. Drinking risk without any other risk behaviour was also more common than expected. In addition, there were four behavioural combinations that occurred less frequently than expected: smoking risk only; F&V and smoking risk;

physical activity and smoking risk; and F&V, physical activity and drinking risk. Details are provided in supplementary table S1.

ii) Multiple health behaviours: identifying latent classes

For both mothers and their partners, the LCA indicated that a 5-class solution was optimal. The 5-class solutions were also very similar for both mothers and partners (Tables 1 and 2) and are summarised below.

Tables 1 and 2 about here

Never-smoked drinkers were the largest group among both mothers (28%) and partners (29%). The group had never smoked. They frequently consumed alcohol (74% of mothers and 89% of partners drank more than once a week), and a sizeable minority binge drank (25% of mothers and 37% of partners), but drank fewer units than other groups who engaged in binge drinking. They were above average consumers of F&V (but 76% of mothers and 80% of partners consumed less than 5 portions a day) and engaged in average physical activity compared to other mothers and partners (71% of mothers and partners did not meet the recommended levels).

Abstainers were the second largest group among mothers (25%) and a smaller proportion (17%) of partners. It also consisted of non-smokers but, unlike the Never-smoked drinkers, they were occasional or non-drinkers. None of the mothers and 1% of partners had drunk more than twice the recommended level per day in the previous week. They had average F&V intake (81% of mothers and 88% of partners did not meet the recommendations) and engaged in slightly below average physical activity (80% and 76% respectively did not meet the recommendation).

Unhealthiest behaviour group represented a similar proportion of mothers (11%) and partners (12%). It contained the highest proportion of current smokers (67%; 86%) and heavy (≥20 a day) smokers (15%; 42%); many started smoking before the age of 16. The group also had the highest proportion of binge drinkers (53%; 69%). They had the lowest F&V intake of any group. Nearly all (94%; 98%) did not meet the recommendation; most (59%; 73%) did not eat any F&V. The group also had the lowest participation in physical activity (91%; 81%). With the exception of physical activity, partners had less healthy lifestyles than mothers in this group.

Drinkers and ex-smokers but the most physically active with highest F&V consumption represented 19% of mothers and was the second largest group among partners (26%). It consisted mainly of ex-smokers (81%; 73%) along with some current light or moderate smokers (19%; 27%), and had a lower proportion that started smoking before the age of 16 than other groups with current or ex-smokers. The group contained frequent drinkers and a high proportion that exceeded the binge drinking threshold (44%; 64%). However, the group had the second highest intake of F&V, but most (66%; 83%) still did not meet the recommendation). It had the most frequent participation in physical activity and the lowest proportion of any group (65%; 65%) did not meet the physical activity recommendation. Partners had unhealthier behaviours than mothers, except for physical activity.

Unhealthy low frequency drinkers contained a similar proportion of mothers (18%) and partners (16%). It consisted of occasional or non-drinkers, and none had exceeded the binge drinking threshold. However, the group was unhealthy in relation to the other three health behaviours.

Large proportions (49%; 56%) were current smokers. They were low F&V consumers; 87% of mothers and 92% of partners consumed less than 5 portions a day. They were also low participators in physical activity; 87% and 92% respectively did not reach the recommended level.

iii) Social patterning of latent classes

The sociodemographic characteristics of the five latent classes are summarised below (patterns are for both mothers and partners unless noted otherwise) and in Figure 1 (mothers) and Figure 2 (partners). Details of the regression models, estimated odds of class membership and the class profiles by sociodemographic factors are given in tables S2-S7.

Figures 1 and 2 about here

Never smoked drinkers were more likely than those in other groups to be older, married, employed, with higher educational qualifications and higher incomes. They were more likely to be white and less likely to be from a minority ethnic background (Indian, Pakistani, Bangladeshi, black African or Arab). In addition, mothers were less likely to have a limiting long-standing illness.

Abstainers were less likely than those in other groups to be white and more likely to be Indian, Pakistani, Bangladeshi, black African/Arab, mixed race and other non-white; they were also more likely to live in middle income households. In addition, mothers were more likely to be married.

Those in the **unhealthiest behaviour** group were more likely to be, white younger, not married and with lower educational qualifications. Mothers were likely to be in the bottom household income quintile and were unlikely to be Indian, Pakistani, Bangladeshi, black African/Arab.

Drinkers and ex-smokers were more likely to have higher educational qualifications and household incomes that lifted them out of the lowest two income quintiles. Mothers in particular were unlikely to be Indian, Pakistani, Bangladeshi, black African or Arab. Mothers were additionally more likely to be older (35-44), cohabitees and less likely to have a limiting long-standing illness. Partners were additionally more likely to have one or two children rather than three or more.

Unhealthy low frequency drinkers were more likely to have no/low educational qualifications, live in a lower-income household and have a limiting long-standing illness. In addition, mothers were less likely to be married and to be Indian, Pakistani, Bangladeshi, black African or Arab and more likely to be younger.

iv) Intra-couple concordance of health risk behaviours and latent class membership

There was a high degree of concordance among couples in their health risk behaviours; the observed associations were all significantly different ($p<0.001$) from what would be expected if the behaviours of a mother and her partner were independent of each other. Concordance ranged from 83% for smoking to 66% for low physical activity (Table 3). In 13% of families, both parents were smokers. In 13% of families, both partners exceeded the threshold for binge drinking. In 72% of couples, neither parent met the '5 a day' recommendation for F&V intake; in 58% of couples, neither met the physical activity recommendations.

Table 3 about here

In 44% of couples, the mother and her partner belonged to the same latent class (sum of the shaded diagonals in Table 4). In the logistic regression analyses, there were significant associations ($p<0.001$) between the behavioural classes to which mothers their partners belonged: they were between three and six times more likely to be members of the same group than not. Odds of belonging to the same latent class were the highest when couples were both Abstainers (6.66; 95%CI 5.19, 8.54) or both allocated to the Unhealthiest class (6.59; 95%CI 4.763, 9.16). Out of the 25 possible class combinations, the largest group of couples (15.1%) were both Never-smoked drinkers (Table 4); they were the largest latent class among mothers (28%) and partners (29%) and had a high odds of living with a partner who was also a Never-smoked drinker (OR=4.60; 95%CI 3.71, 5.69). The odds of Unhealthy low frequency drinkers living together was 4.44 (95%CI 3.39, 5.81) and of Drinkers and ex-smokers living together was 3.30 (95%CI 2.56, 4.25).

Table 4 about here

DISCUSSION

Focusing on parents, we examined the inter-relationships and social patterning of the four health behaviours that contribute most to chronic disease. As far as we are aware, ours is the first study to focus on this key population group.

We based our study on the UK's largest nationally-representative household survey. We exploited three features of the UKHLS: the inclusion of questions on health behaviours in the 2010/11 survey, its household structure and its rich social data. Its range of behavioural questions enabled us to derive measures of risk behaviours based on government guidelines along with a wider set of measures of the four behaviours. Its household structure permitted analysis of intra-couple concordance in risk behaviours and behavioural classes and its rich social data meant we could investigate the patterning of behavioural classes by multiple dimensions of social background and identity.

Using O/E-based analyses, we found clustering at both ends of the risk continuum: not meeting recommendations for any behaviour and meeting all the recommendations occurred more than would be expected if the behaviours were independent. In studies of the general population, a similar clustering has been found (Berrigan, Dodd, Troiano, Krebs-Smith, & Barbash, 2003; Laaksonen, Prättälä, & Karisto, 2001; Poortinga, 2007; Schuit, van Loon, Tijhuis, & Ocke, 2002). However, as in other studies, only a small proportion fell into these outlier groups: 8% of mothers and 10% of partners. For over 70% of mothers and partners, risk behaviours combined in ways that did not differ significantly from the patterns expected based on their separate prevalence.

Using a wider range of behavioural measures, the latent class analyses enabled us to identify five latent classes to which mothers and partners could be allocated. The behavioural classes were independently estimated for mothers and partners but were similar for both, adding confidence to our analysis.

Like the O/E-based approach, the LCA pointed to a high-risk group (Unhealthiest behaviour group). This group contained the highest proportion of smokers, heavy smokers, binge drinkers and those both failing to meet the recommendation for F&V and consuming no F&V. It also contained the

lowest proportion meeting the physical activity recommendation. Other studies have suggested that addictive behaviours like smoking and alcohol consumption cluster (de Vries, 2008) and that smoking has the strongest and most consistent associations with other risk behaviours (Berrigan et al., 2003; Laaksonen et al., 2001; Poortinga, 2007; Schuit et al., 2002). However, our latent classes included ones in which smoking was associated with occasional and low alcohol intake (Unhealthy low frequency drinkers) and conversely never smoking was part of a lifestyle that included frequent drinking (Never smoked drinkers). The group least likely to either smoke or to drink was the Abstainers. While their lifestyles were health-promoting with respect to these behaviours, other groups had higher levels of F&V consumption and physical activity, including the Drinkers and ex-smokers. As these patterns suggest, health behaviours combine in more varied ways than characterisations of 'high risk' and 'low risk' groups may suggest.

With respect to the social patterning, socioeconomic background has long been known to be a predictor of multiple health behaviours. Our study additionally highlighted the importance of ethnic background. With the exception of partners who were Unhealthy low frequency drinkers, both social factors influenced the probability of belonging to a latent class. Thus, never smoking and frequent drinking was associated with multiple advantages: being white, older, more highly educated and better-off. Conversely, the combination of never smoking and never drinking (Abstainers) was more strongly associated with being from a minority ethnic group and living in a low to middle-income household. Indeed the overwhelming majority of parents from minority ethnic groups fell into this group. Other UK studies have pointed to healthier behaviours among minority ethnic groups (Lawder et al., 2010); however in our study, Abstainers had average F&V intake and below average levels of physical activity. The latent class occupied by a high proportion of drinkers and ex-smokers again had a distinctive social profile: more socio-economically advantaged and less likely to belong to a minority ethnic group. Parents with the most health-damaging lifestyles (heavy smoking, binge drinking, diets with little or no F&V, and low levels of physical activity) were most likely to be white and socially disadvantaged.

With respect to intra-couple concordance, mothers and partners often had risk behaviours in common. This meant that children in most families were growing up with parents who were both non-smokers; however, in 1 in 8 families, both were smokers. Similarly, in most families neither parent reported drinking at levels that met the threshold for binge drinking. However, in 1 in 8 families, both parents were binge drinkers. In a larger proportion (over half) of households, neither parent met the physical activity guidelines; in over 70%, neither parent met the dietary recommendations. Because the analyses were cross-sectional, we were unable to examine whether an individual's health behaviours influence those of their partner's, e.g. whether a smoker quits smoking when in a cohabiting relationship with a non-smoker.

We also found significant associations in the latent classes to which mothers and their partners belonged: mothers and partners were much more likely than not to be members of the same behaviour group. Couples where both partners were Never-smoked drinkers made up the largest group of couple combinations. This suggests that, in around 1 in 7 two-parent families, never smoking but frequent alcohol consumption by both parents is a common pattern; in this group, a sizeable minority (1 in 4 mothers and over 1 in 3 partners) also binge drank. As noted above, parents in this group are likely to enjoy a range of social and material advantages. This can be contrasted with the Abstainer couples, who represented 1 in 10 of couples. Compared to other groups, these

non-smoking and low/non-drinking families are characterised by their greater socio-economic disadvantage (higher rates of unemployment and economic inactivity and middle to lower incomes).

Some limitations of our study should be noted. The UKHLS included a restricted range of health behaviour questions from which to derive proxies for current (2010/11) recommendations (Box 1). For alcohol consumption, our focus was restricted to binge drinking in the previous week; we were unable to consider government guidelines on weekly consumption. It should also be noted that the binge drinking recommendation has been revised by the UK government; in 2016, the threshold for men was lowered to match the one for women (Department of Health, 2016). In addition, like most studies of health behaviours, our study is based on self-reported data which are less reliable than objective measures (Celis-Morales et al., 2012). In addition, questions on three of the behaviours were asked as part of the interviewer-administered component; such questions are more susceptible to response bias (Tipping et al., 2010). Alcohol intake was recorded in a confidential self-completion questionnaire, potentially reducing social desirability bias (Tipping et al., 2010). However, parents from minority ethnic groups tended not to answer the alcohol questions, requiring data imputation.

Focused on couples, our study excluded lone parent families, the large majority of which were female-headed. Rerunning the analyses of partnered mothers to include all mothers left the results for all analyses substantively unchanged.

Finally, there is a diversity of approaches to latent class analysis, including approaches to the inclusion of covariates. Results can be difficult to compare across studies because they are highly dependent on the measures and methods of analysis (Berrigan et al., 2003; de Vries et al., 2008; McAloney et al., 2014; N. Noble et al., 2015; N. E. Noble et al., 2015). The allocation of individuals to a class is based on their having the highest probability of being in it for their given behaviour profile, but the behaviours of those allocated to the same class can vary between individuals.

CONCLUSION

While there is increasing research on multiple risk behaviours, little attention has been given to parental behaviours and how they covary. Our study focused on mothers and co-resident partners, the domestic unit in which the majority of children are brought up, and investigated the four health behaviours that contribute most to chronic disease and premature mortality. We uncovered five distinctive behavioural groups. By predicting membership of these groups on the basis of socio-economic and ethnic background, we could identify the ways in which patterns of health behaviour were differentiated by social position.

Such evidence offers insights for public health policies informed by social determinants of health perspectives, where both behavioural factors and social circumstances are identified as shaping people's health (Marmot, Allen, Bell, Bloomer, & Goldblatt, 2012). It suggests that these perspectives could be used in differentiated ways for different sub-groups. For example, parents with the most health-damaging lifestyles (heavy smoking, binge drinking, diets with little or no F&V, and low levels of physical activity) were most likely to be white and socially disadvantaged. Policies that address the wider determinants of their social disadvantage – over their life course and through the early years of their children's lives - are therefore likely to be essential if their lifestyles are to improve. However, in our study the largest group of mothers and partners were not socially disadvantaged. The never smokers who drank frequently (and failed to meet recommendations for diet and physical activity) were characterised by their multiple social advantages. They were more

likely to be white, well-educated, married and well-off. In this group, policies tackling wider determinants like low educational attainment and low income would be unlikely to be accompanied by improvements in their lifestyle. Instead, information-based approaches explicitly targeted at the lifestyles of advantaged families may offer a more effective approach.

If future studies identify a similar combinations and social patterning of multiple health behaviours, our findings would support a shift in public health research and policy from individual health behaviours to combinations of behaviours, as well as from individuals to the domestic units and communities of which they are part.

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Box 1: measures of health risk behaviours (in italics) aligned to government recommendations (in bold)

Smoking recommendation: do not smoke

Smokes ≥1 cigarette a day

Alcohol consumption recommendation: on most days do not drink more than 2-3 units (women) or 3-4 units (men) of alcohol a day and on no days drink more than 6 units (women) or 8 units (men)

Consumed more than twice the daily recommended units of alcohol on their heaviest drinking day in the past week ('binge' drinking): > 6 units (women) or >8 units (men)

Fruit and vegetable consumption recommendation: eat at least 5 portions of fruit and/or vegetables a day)
Consumed <5 portions of fruit and vegetables on average per day

Physical activity recommendation: engage in at least 150 minutes a week of moderate to vigorous intensity physical activity per week in bouts of 10 minutes or more, or engage in at least 75 minutes a week of vigorous intensity physical activity or an equivalent of the two)

Did not engage in

- *30 minutes or more of brisk or fast walking 20 times in the past four weeks*
- *or moderate to vigorous activity more than 3 days a week*
- *or did not engage in a combination of these activities (i.e. 30 minutes or more brisk or fast walking for 4 days a week and 1 day or more a week moderate to vigorous sports activity)*

(For further information on government guidelines, see Department of Health, 2003, 2005, 2011, 2013a, 2013b)

Box 2: behavioural measures used in the LCA

- Smoking status (6 categories incl. non-smoker, ex-regular smoker & average current daily cigarette consumption)
- Age started smoking (5 categories)
- Drinking frequency (9 categories)
- Number of alcoholic units consumed on the heaviest day in the past 7 days (8 categories)
- Fruit and vegetable portions consumed per day (4 categories)
- Number of days walking briskly or fast paced in the past 4 weeks (7 categories)
- Frequency of participation in moderate to vigorous sporting activities over the last 12 months (7 categories)

Table 1 Latent classes: mothers

Behaviours	Classes					
	Never-smoked drinkers	Abstainers	Unhealthiest	Drinkers & ex-smokers	Unhealthy low frequency drinkers	All
	%	%	%	%	%	%
Group size	28	25	11	19	18	100
Smoking status						
non-smoker	88	94				48
past experimenters	12	6				5
Ex-regular smoker			33	82	51	28
Current smoker - light			12	15	14	7
Current smoker - moderate			41	2	23	9
current smoker – heavy			15	0	12	4
Age started smoking						
Never smoked/not regular smoker	100	100				53
Under 16			56	29	45	20
16-18			34	46	39	19
19-24			8	21	13	7
25+			1	4	3	1
Drinking frequency						
Almost everyday	5	0	10	7		4
5/6 days per week	7		5	10		4
3/4 days per week	20		17	28		13
Once or twice a week	42	5	45	32	4	24
Once or twice a month	19	13	17	16	20	17
Every couple of months	6	15	5	3	27	12
Once or twice a year	0	20	1	2	31	11
Haven't had a drink in last year		9			7	4
Didn't answer question		37		1	10	11
Number of units on heaviest drinking day						
Did not drink in past week	1	96	1	2	91	41
Up to and including 2	24	3	5	13	7	12
Over 2 and up to (& including) 3	5		3	2	1	2
Over 3 and up to (& including) 4	24		14	21	1	12
Over 4 and up to (& including) 5	3	1	6	1		2
Over 5 and up to (&including) 6	18		18	18		10
Over 6 and up to (& including) 8	12		19	16		9
Over 8	13		34	27		12
Fruit and vegetable portions per day						
5 or more portions	24	19	6	34	13	21
3 or 4 portions	43	35	16	39	26	34
1 or 2 portions	8	15	19	7	13	12

none	24	31	59	20	48	33
Not meeting F&V recommendations	*75.8*	*81.3*	*94.1*	*66.1*	*86.6*	*79.2*
Number of days brisk or fast paced walking in past 4 weeks						
None	59	74	85	51	74	67
1-4days	11	6	5	12	9	9
5-9 days	7	5	3	9	4	6
10-14 days	6	3	2	8	3	5
15 to 19 days	3	1		3	1	2
20 to 24 days	6	6	3	4	4	5
25 to 29 days	9	5	2	13	5	7
Frequency of participation in moderate activity						
no moderate activities	13	43	42	6	40	27
three or more times a week	17	12	4	24	8	13
at least once a week	27	15	6	28	13	18
at least once a month	20	12	13	21	16	16
at least 3 or 4 times a year	16	12	22	12	14	15
twice in last 12 months	5	4	10	5	5	6
once in last 12 months	3	3	3	4	3	3
Not meeting physical activity recommendations	*71.3*	*80.4*	*90.7*	*65.1*	*84.6*	*76.7*
Unweighted Bases	880	1118	301	567	531	3397
Weighted Bases	867	771	330	582	565	3115

Table 2 Latent classes: partners

Behaviour	Classes					
	Never-smoked, drinkers	Abstainers	Unhealthiest	Drinkers & ex-smokers	Unhealthy low frequency drinkers	All
	%	%	%	%	%	%
Group size	29	17	12	26	16	100
Smoking status						
non-smoker	83	92				39
past experimenters	17	8				6
Ex-regular smoker			14	73	45	28
Current smoker - light			1	21	14	8
Current smoker - moderate			43	6	25	11
current smoker – heavy			42		17	8
Age started smoking						
Never smoked/not regular smoker	100	100				46
Under 16			60	30	44	22
16-18			33	44	35	21
19-24			7	20	14	8
25+				5	7	2
Drinking frequency						
Almost everyday	8		26	11		9
5/6 days per week	7		7	12	3	7
3/4 days per week	29		18	29		18
Once or twice a week	45	8	34	33	9	29
Once or twice a month	10	21	10	13	27	15
Every couple of months	1	20	4	1	21	8
Once or twice a year	0	15	1		18	5
Haven't had a drink in last year		7			7	2
Didn't answer question		29	0		15	7
Number of units on heaviest drinking day						
Did not drink in past week	1	86		0	86	28
Up to and including 2	11	8		8	10	8
Over 2 and up to (& including) 3	1	1	0	1	0	1
Over 3 and up to (& including) 4	17	3	5	13	2	10
Over 4 and up to (& including 5	2			1	0	1
Over 5 and up to (&including 6)	16	1	10	12	1	9
Over 6 and up to (& including 8)	16		15	17		11
Over 8	37	1	69	47		32
Fruit and vegetable portions per day						
5 or more portions	20	12	2	17	8	14
3 or 4 portions	30	27	14	29	17	25
1 or 2 portions	12	16	12	16	18	15

none	38	45	73	38	57	46
Not meeting F&V recommendations	*79.9*	*88.0*	*97.9*	*83.0*	*91.6*	*86.0*
Number of days brisk or fast paced walking in past 4 weeks						
None	51	70	67	54	63	59
1-4days	16	11	12	14	12	14
5-9 days	11	4	4	6	8	7
10-14 days	6	4	3	6	4	5
15 to 19 days	3	1	3	3	1	2
20 to 24 days	5	4	5	6	1	5
25 to 29 days	9	7	5	10	10	8
Frequency of participation in moderate+ sporting activity						
no moderate activities	11	33	39	6	32	20
three or more times a week	19	14	9	25	13	17
at least once a week	27	19	15	25	17	22
at least once a month	20	16	10	23	14	18
at least 3 or 4 times a year	16	12	16	16	17	16
twice in last 12 months	4	3	7	3	5	4
once in last 12 months	2	2	4	3	2	3
Not meeting physical activity recommendations	*70.5*	*75.9*	*81.3*	*65.1*	*79.3*	*72.6*
Unweighted Bases	706	531	265	617	435	2554
Weighted Bases	750	425	313	677	405	2570

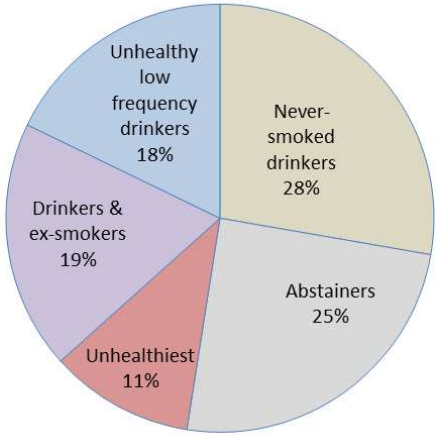
Figure 1. Social patterning of mothers' latent classes

Overall probability of membership for **Unhealthy low frequency drinkers** is **18**% but this varies with:

- *Age* (16-34=21%; 35-44=17%; 45-74=14%)
- *Marital status* (cohabiting =25%; married=16%)
- *Education* (no qualifications or up to O-level=21-22%; degree=11%)
- *Household income* (bottom fifth=23%; top fifth=13%)
- *Ethnicity* (white=20%; Indian, Pakistani, Bangladeshi, black African or Arab, or mixed=5%)
- *Limiting long-standing illness* (Yes=27%; No=17%)

Overall probability of membership for **Never-smoked drinkers** is **28**% but this varies with:

- *Age* (45+=34%; 16-34=22%)
- *Marital status* (married=30%;cohabiting=21%)
- *Education* (degree=34%; no qualifications=21%)
- *Household income* (top fifth=32%; bottom fifth=21%)
- *Economic activity* (working=30%; econ inactive=21%)
- *Ethnicity* (white=31%; Indian, Pakistani, Bangladeshi, black African or Arab=8%)
- *Limiting long-standing illness* (No=28%; Yes=21%)



Overall probability of membership for **Drinker & ex-smokers** is **19**% but this varies with:

- *Age* (35-44=20%; 16-34=16%)
- *Education* (degree=22%; no qualifications=12%)
- *Household income* (top fifth=22%; bottom fifth=12%)
- *Ethnicity* (white=21%; Mixed race=23%; Indian, Pakistani, Bangladeshi, black African or Arab=1%)

Overall probability of membership for **Abstainers** is **25**% but this varies with:

- *Marital status* (married=27%; cohabiting=19%; single/previously married=17%)
- *Economic activity* (working=22%; econ inactive=24%)
- *Household income* (second to bottom fifth=28%; top fifth 22%)
- *Ethnicity* (Indian, Pakistani, Bangladeshi, black African or Arab=86%; mixed race=47%; white=16%; other non-white=58%)

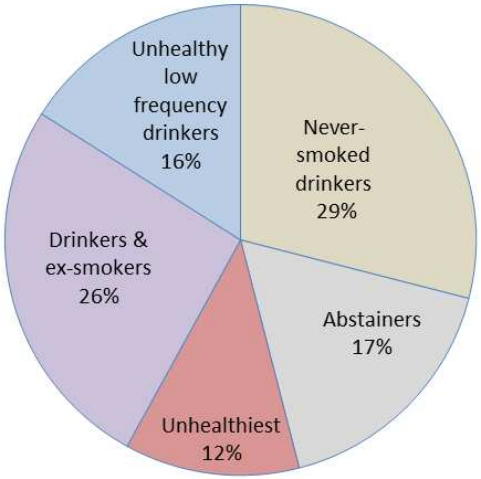
Overall probability of membership for **Unhealthiest** is **11**% but this varies with:

- *Age* (16-34 years=13%; 35-44 years =9%)
- *Marital status* (cohabitees=14%; married=9%)
- *Education* (no qualifications or up to O-level=13-15%; degree=5%)
- *Ethnicity* (white=12%; Indian, Pakistani, Bangladeshi, black African or Arab<1%)

Figure 2. Social patterning of partners' latent classes

Overall probability of membership for **Unhealthiest low frequency drinkers** is **16%** but this varies with:
- *Education* (no qualifications =19%; degree=12%)
- *Household income* (bottom fifth=23%; top fifth=9%)
- *Limiting long-standing illness* (Yes=22%; No=15%)

Overall probability of membership for **Never-smoked drinkers** is **29%** but this varies with:
- *Age* (45+=34%; 16-34=22%)
- *Marital status* (married 31% cohabiting=20%)
- *Education* (degree=35%; no qualifications=22%)
- *Household income* (top fifth=35%; bottom fifth=24%)
- *Economic activity* (working=30%; econ inactive=18%)
- *Ethnicity* (white=32%; Indian, Pakistani, Bangladeshi, black African or Arab=12%)
- *Age of Youngest* (under 10 years of age=30-31%; over 10 years of age=25%)



Overall probability of membership for **Drinkers and ex-smokers** is **26%** but this varies with:
- *Education* (degree=29%; no qualifications=22%)
- *Household income* (top two fifths=29-30%; bottom fifth=19%)
- *Ethnicity* (white=28%; Mixed race=32%; Indian, Pakistani, Bangladeshi, black African or Arab=10%)
- *Children* (1-2 = 27-29%; 3 or more =18%)

Overall probability of membership for the **Unhealthiest** is **12%** but this varies with:
- *Age* (16-34 years=16%; 35+ years=10-11%)
- *Marital status* (cohabiting=16%; married=11%)
- *Education* (no qualifications=19%; degree=4%)
- *Ethnicity* (white=13%; Indian, Pakistani, Bangladeshi, black African or Arab=3%)

Overall probability of membership for **Abstainers** is **17%** but this varies with:
- *Household income* (middle fifth=20%; top fifth 11%)
- *Ethnicity* (Indian, Pakistani, Bangladeshi, black African or Arab=53%; mixed race=24%; white=12%; other non-white=40%)

Table 3: Single risk behaviours of mothers and their partners				
Behaviours		Mothers		Total (%)
		No Risk (%)	**Risk (%)**	
Smoking		Non-smoker	Smoker	
Partners	Non-smoker	70	6	76
	smoker	11	13	24
	Total	81	19	100
Binge drank in last 7 days		Below binge levels	Binge drank	
Partners	Below binge levels	59	9	68
	Binge drank	19	13	32
	Total	78	22	100
Fruit and vegetable portions per day		5 or more a day	Less than 5 a day	
Partners	5 or more a day	6	7	14
	Less than 5 a day	14	72	86
	Total	20	80	100
Walking fast or briskly 5 days / week or moderate+ activity 3 days/ week		High physical activity	Low physical activity	
Partners	High PA	8	20	28
	Low PA	15	58	72
	Total	23	77	100

p<0.001 for all four cross-tabulations

Table 4 Latent classes of mothers and their partners							
		Mother's latent class					total
		Never-smoked drinkers	Abstainers	Unhealthy Low freq drinkers (LFD)	Unhealthiest	Drinkers & ex-smokers	
Partner's latent class	Never-smoked, drinkers	15.1%	6.1%	1.9%	1.5%	5.5%	30.2%
	Abstainers	2.0%	9.6%	3.0%	0.5%	1.0%	16.1%
	Unhealthy LFD	1.7%	4.8%	6.6%	1.3%	1.4%	15.8%
	Unhealthiest	1.6%	1.1%	3.3%	4.1%	1.8%	11.9%
	Drinkers & ex-smokers	7.2%	3.2%	3.6%	3.3%	8.7%	26.0%
	Total	27.5%	24.8%	18.4%	10.8%	18.4%	100%

$p<0.001$ overall for chi^2 cross-tabulation

Little is known about the multiple health behaviours of couples with children

Mothers and partners belong to five similar health behaviour groups (latent classes)

Mothers and partners were more likely than not to belong to the same class

The largest class - never smokers who drank frequently - were socially advantaged

Those with the unhealthiest behaviours were more likely to be white and disadvantaged

Supplementary appendix: methods details and supplementary tables

A1 Sample details (mothers living with partners and their partners)

There were 3585 mothers and 2696 partners who returned both the self-completion questionnaire and completed the Computer Assisted Personal Interviewing (CAPI) questionnaire which together contained the questions relating to the four health behaviours; 676 (16%) of mothers and 467 (15%) of partners did not return the self-completion questionnaire. Those who returned the self-completion were significantly more likely to be older, white, employed, have higher household income and have older and fewer children living at home. There were 2623 couples in the UKHLS where both the mother and their co-resident partner returned the self-completion questionnaire and completed the CAPI questionnaire; 540 (17%).

The latent class analyses used to produce the behavioural clusters included 3397 (weighted 3115) mothers and 2554 (weighted 2570) partners; all mothers and all partners who answered the behaviour questions were included whether or not the partners answered the questions. Similarly all mothers and all partners where included in the socio-demographic analyses of the LCA if they answered the behaviour and sociodemographic questions. Some alcohol values were imputed for participants from minority groups who returned the self-completion questionnaire but provided no answers for the alcohol questions (see alcohol intake section below). For the analyses of intra-couple concordance of LCA behavioural clusters, 2361 (weighted 2404) couples provided or had imputed responses for both partners for all the measures in Box 2: couples were excluded where one or both adults did not return the self-completion questionnaire.

For the analysis of intra-couple concordance of the four risk behaviours, 2538 (weighted 2553) couples provided responses or had imputed values for all four behaviours for both partners. (Similarly only these respondents were included in the separate mother and partner observed/expected ratio analyses of the four risk behaviours).

Number of individuals who took part in survey and were included in the analyses (unweighted)

	Mothers	Partners	Couples
Completed CAPI and returned self-completion questionnaire	3585	2696	2623
Included in LCA	3397	2554	2361
Included in intra-couple concordance analyses for 4 risk behaviours			2538
Included in Observed/ Expected ratios	2538	2538	-

A2 Health behaviour questions

Fruit and vegetable intake:

The interview included questions on the total number of portions and the number of days that fruit and vegetables were consumed:

1) *On a day when you eat fruit or vegetables, how many portions of fruit and vegetables in total do you usually eat? The showcard has some pictures that may give you an idea of what a portion looks like.*

2) *Including tinned, frozen, dried and fresh fruit, on how many days in a usual week do you eat fruit?*

Individuals who did not report consuming five portions of fruit and vegetables for seven days in a usual week in the UKHLS were classed as not meeting government recommendations (DoH, 2003) i.e. as having a risk behaviour. Four categories of intake were used in the LCA; these are summarised in Tables S.1 and S.2.

Physical activity:

The interview included questions on duration and intensity of walking.

I'd like you to think about all the walking you have done in the past four weeks either locally or away from home. Please include any country walks, walking to and from work or college and any other walks that you have done.

On how many days in the last four weeks did you spend 30 minutes or more walking? This could be made up of more than one walk.

Which of the following best describes your usual walking pace?

> *A slow pace; a steady average pace; a fairly brisk pace; a fast pace – at least 4 miles per hour; Spontaneous (e.g. None of these).*

Information was gathered on how many days the individual had walked fast or briskly for 30 or more minutes in the last four weeks. Walking briskly - which can cause adults to get warmer, breathe harder and their hearts to beat faster - was classed as moderate activity (DoH 2011); therefore minutes of walking fast or briskly were used to estimate whether adults had done at least the recommended 150 minutes of moderate intensity exercise per week.

Questions on other physical activity were limited; only questions on sporting activity were asked (see box below) and the highest category asked in relation to frequency was three or more days a week. Therefore an approximation to meeting government guidelines was used:

> 30 minutes or more of brisk or fast walking 20 times in the past four weeks, or 3 days or more a week moderate to vigorous sporting activity, or 1 day a week moderate to vigorous sporting activity and 4 days a week brisk or fast walking for 30 minutes or more.

For the latent class analyses, seven categories were used for number of days walking briskly or fast paced in the past 4 weeks. Additionally, seven categories for frequency of participation in moderate to vigorous sporting activities over the last 12 months were used. These are listed in tables S.1 and S.2.

Here is a list of sporting activities. Please tell me which ones, if any, you have done in the last 12 months?

> *Health, fitness, gym or conditioning activities; gymnastics; swimming or diving; cycling, BMX or mountain biking; football; rugby; track and field athletics; jogging, cross-country, road-running; hill trekking, backpacking, climbing or mountaineering; golf; boxing; martial arts; water sports (including*

sailing types); horse riding; nothing of this kind.

And have you done any of these sporting activities in the last 12 months? Please include ALL sports activities you have done. If there are any other sport activities you want to mention, just let me know which ones.

Basketball; netball; volleyball; cricket; hockey; baseball, softball or rounders; racquet sports; ice-skating; ski-ing; motor sports; angling or fishing; archery (64< only); yoga or pilates (64< only); bowls (64< only); croquet (64< only); Other sporting activity such as triathlon, fencing, lacrosse, orienteering, curling, Gaelic sports, skate boarding, parachuting, scuba diving; nothing of this kind.

How often in the last 12 months have you done this/these sport(s)? If there is a 'peak season' for some of these sports then please bear this in mind when thinking of your answer.

- *Three or more times a week;*
- *at least once a week but less than 3 times;*
- *less than once a week but at least once a month;*
- *less than once a month but at least 3 or 4 times a year;*
- *twice in the last 12 months;*
- *once in the last 12 months.*

Smoking:

The questions were:

Have you ever smoked a cigarette, a cigar or a pipe?

Yes/No. If Yes:

Do you smoke cigarettes at all nowadays?

Yes/No. If Yes to both:

Approximately how many cigarettes a day do you usually smoke, including those you roll yourself?

(If less than 1 per day on average, zero is entered)

If Yes to first question and No to second:

Have you ever smoked cigarettes regularly, that is at least one cigarette a day, or did you smoke them only occasionally?

Smoked regularly, at least one per day; smoke them only occasionally; Spontaneous (e.g. never really smoked, just tried them once or twice).

Six categories for smoking status, including non-smoker, ex-regular smoker & average current daily cigarette consumption, and five categories for age started smoking were used to produce the lifestyle groups in the latent class analyses (see Tables 1 and 2).

Alcohol intake:

Adults were asked separate questions for different groups of alcohol consumed:

'…in the last seven days, on the day you drank the most, how many….'

1) *pints of beer, lager, stout or cider*
2) *measures of spirits or liqueurs, such as gin, whisky, rum, brandy, vodka or cocktails*
3) *glass of wine including sherry , port*
4) *alcopops*

These were converted into units of alcohol intake using values of 2 units per pint (based on normal strength beer, larger, stout and cider); 1 unit per single spirit measure; 2 units per glass of wine (assuming an average glass size of 175ml); and 1.5 units per alcopop. Although previous research on the General Household Survey 2005 data (Goddard, 2007) has shown that men are more likely to drink strong beers and lagers than women (which are about 6%+ alcohol by volume and on average equivalent to 3 units per pint), these accounted for a very small proportion of total alcohol consumed (6% of total units for men and 2% for women (Goddard, 2007). The underestimation of the total units drank by UKHLS men is therefore likely to be modest.

Individuals who drank more than twice the daily recommended units of alcohol on their heaviest drinking day in the past week (for women more than 6 units and for men more than 8 units) were classed as binge drinkers (see Box 2). Drinking below this level was one of the government guidelines (Box 1). Lower-risk guidelines for alcohol state that men should not regularly drink more than 3 to 4 units per day and women should not regularly drink more than 2 to 3 units per day. 'Regularly' means drinking most days or every day (2013b). For our analyses, we chose the binge drinking cut-off to as defining 'health risk behaviour' because evidence of its health effects is stronger than for the lower-risk guidelines (DoH, 2005).

Information on alcohol consumption was gathered by self-completion questionnaire. A high proportion of respondents from ethnic minority groups did not answer the self-completion questions. For instance 41% of Indian mothers (and 28% of partners), and 71% of Pakistani mothers (and 62% of partners) and 73% of Bangladeshi mothers (70% of partners) did not answer questions on the amount they drank, and the majority of these were Muslim, Sikh or Hindu. Values for units drank on the heaviest day of alcohol consumption were assigned to ethnic minorities with missing responses; these were based on median values for others in their ethic group who had completed the alcohol questions. These median values were further sub-grouped by religion (Muslim, Sikh or Hindu; or not), and whether or not they were born in the UK, and for mothers, whether they were partnered or single mothers. For mothers in particular, the majority of the relevant sub-groups had median values of zero, resulting in 98% of values assigned to mothers with missing responses being zero. Eighty five percent of values assigned to partners with missing responses were zero.

The assignment of zero values is in-line with findings from the 2004 HSE survey by Becker et al (2006) who reported very high abstinence rates for Pakistani men and Pakistani women (85% and 95%) and Bangladeshi men and women (97% and 98%), and reported over 70% of Indian and black African women not drinking in the previous 7 days. The median values assigned for missing responses were used in the analyses of risk of binge drinking (i.e. consuming over 6 units of alcohol for women and over 8 for men). In addition, most of these women also did not answer the self-completion question on frequency of alcohol consumption used in the latent class analyses. A separate category for missing responses was created.

A3 Weighting

All values presented in the paper are weighted, including the number of individuals in the analyses.

The UKHLS general population sample from Great Britain (England, Scotland and Wales) is an equal probability clustered sample drawn from the Postcode Address File. The ethnic minority boost sample specifically targeted areas of high ethnic density to recruit ethnic minority individuals, and in particular to achieve a sample of 1,000 each of Indian, Pakistani, Bangladeshi, Caribbean and African individuals. The data were weighted to reflect the population in England using weights provided by

the Understanding Society team (Understanding Society, 2012). Weighting also took account of non-responses.

Additionally, as noted above, information on alcohol intake was gathered by self-completion questionnaire; fewer respondents completed this than the interviewer-led questionnaire. Therefore, UKHLS weights were used in the multiple health behaviour analyses which weighted the data based on those who returned the self-completion.

Weighting of the concordance analyses, which included both mothers and their partners, used the complex survey design weight allocated to the partners since there were few partners than partnered mothers. Where percentages in tables and graphs add up to 99% or 101% instead of 100%, this is due to rounding.

A4 Further details of analysis methods

Single behaviours

Differences in the prevalence of the four individual behaviours were produced using two or more categories for each behaviour. Adjusted Wald F tests, which took account of clustered and stratified sample design, were used in bivariate analyses to determine significant associations between single health behaviours and categories of socio-demographic factors (at $p<0.05$). This test was also used to determine significant associations in single health behaviours between household members.

Observed expected ratios

These were calculated as a ratio using the observed prevalence (O) of each combination of the four behaviours and the expected prevalence (E), based on the absolute prevalence of the behaviour in the sample. Thus for four risk behaviours, we have:

$$Ratio = \frac{O_{behaviour1} \times O_{behaviour2} \times O_{behaviour3} \times O_{behaviour4}}{E_{behaviour1} \times E_{behaviour2} \times E_{behaviour3} \times E_{behaviour4}}$$

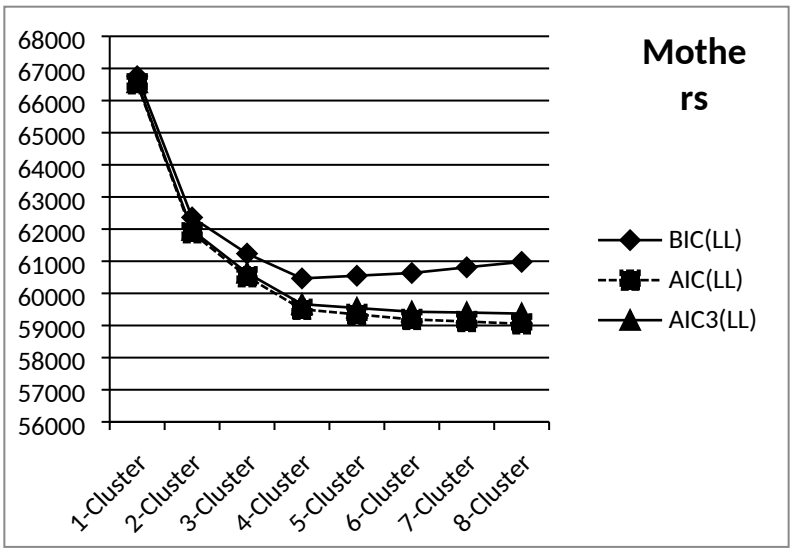
This ratio was calculated for various combinations of the behaviours. Values >1 for this ratio indicate a prevalence greater than that expected if the behaviours were independent; values <1 indicate a prevalence lower than expected if the behaviours were independent. Significance of this clustering was determined by normal approximation with 95% confidence intervals.

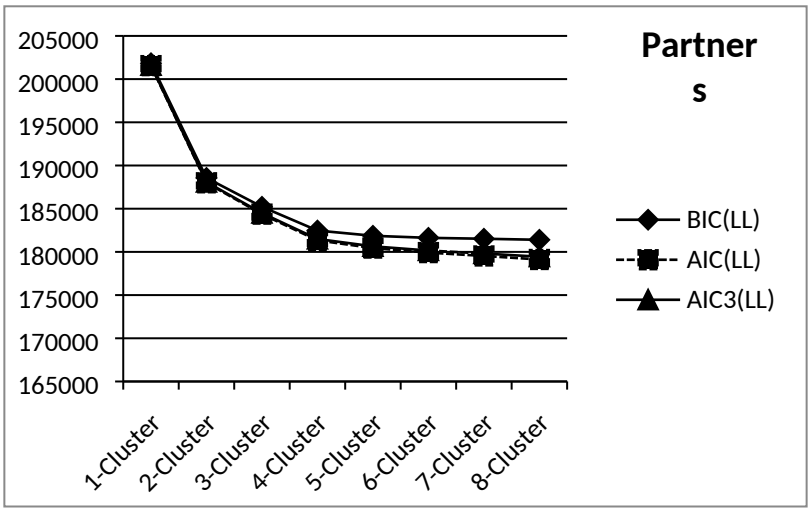
Latent Class Analysis (LCA)

The LCA for mothers and partners was undertaken separately. For each, we produced seven solutions (ranging from two to eight classes) and used the following five ways to check these and decide on the optimal solution:

(a) We looked at measures of fit such as Akaike's Information Criterion (AIC and AIC3) and the Bayesian Information Criterion (BIC). In comparing different models with the same set of data, models with lower values of these information criteria were preferred where the curve levels off, i.e. those of 4 or more classes.

Measures of fit across LCA solutions ranging from 2 to 8 classes





(b) We looked at the misclassification rate. The expected misclassification error for a class solution was computed by cross-classifying the modal classes by the actual probabilistic classes. The sum of individuals in the diagonal of this cross-classification corresponds to the number of correct classifications achieved by the modal assignment of class probabilities. The following formula was then applied: error=100-(100*correct classifications/all individuals). Models with lower misclassification rates were preferred. For mothers and partners misclassification rates were low; they were between 7.0 and 7.5% for the final class solutions which are shaded grey in the Table below.

Misclassification error rates % when comparing assigned modal classes with probabilistic classes

	Misclassification error rates %						
	2-class	3-class	4-class	5-class	6-class	7-class	8-class
mothers	0.0	1.3	3.4	7.0	11.0	13.5	14.1
partners	0.0	1.4	3.3	7.5	9.6	12.7	13.3

(c) We looked at the percentage of cases in each class with a low probability of class membership. We chose solutions where the vast majority of individuals in a class exhibited a high probability of belonging to the class i.e. above 0.6. There were less than 5% of cases with a lower probability than 60% of class membership for the majority of classes in the final class solution.

Percentage of cases with cluster membership probability less than 60% (five-cluster solution)

	Percentage of cases				
	Class 1	Class 2	Class 3	Class 4	Class 5
mothers	0.3%	0.8%	9.1%	3.4%	12.4%
partners	1.3%	6.9%	1.9%	2.7%	13.7%

(d) We chose solutions where the resulting classes were stable. For example, when moving from a four to a five class solution, one of the classes from the four-class solution split to form two classes in the five-class option with the remaining classes remaining largely unchanged. Class stability was investigated by cross-classifying successive class solutions.

(e) The resulting classes have to be interpreted. In deciding the number of classes, we attached particular importance to interpretability.

Social patterning of multiple risk behaviours

LCA class membership was used as the dependent variable and socio-demographic variables were used as predictor variables. Although a large number of variables relating to socio-economic status were available, to avoid over adjustment only two of these were applied in the main logistic analyses: education and equivalised gross household income.

The final logistic regression models for each LCA were estimated in Stataversion 12 within the survey module (svy) which takes into account the complex sample and weighting structure of UKHLS. First, stepwise logistic regression models were estimated to determine the socio-demographic predictors for the final models. Because stepwise regression is not available in Stata's survey module, the stepwise procedure for each model considered was simulated in Stata using the following steps:

A. A forward stepwise logistic regression with all independent variables was initially run outside the svy module.
B. The variables identified as significant (at the 95% significance level) were then included in an "svy logit" regression to test whether they remained significant.
C. If one variable was found to be not significant ($p>0.05$), it was removed from the model, and the model with the remaining variables was re-run and re-checked.
D. If more than one variable were found to be not significant, the one with the largest p-value was removed and the model with the remaining variables was re-run and re-checked.
E. When no more variables could be removed (i.e. when all were $p<0.05$), all other variables not in the model were added back one-by-one.
F. If none of the additional variables were significant, the procedure stopped and the initial model from step E was the final model.

G. If one of the additional variables was significant, then the variables already in the model were checked for removal. Variables were removed one at a time (the variable with the largest p-value was removed first), until no more variables could be removed.
H. If more than one additional variable was significant, the one with the smallest p-value entered the model and the remaining variables were checked for removal in the same way as in step G. The remaining significant variables were then entered, one at a time, based on their p-value (variables with the smallest p-value taking precedent) and after each entry the model was re-checked for variable removals.
I. If at this step the current model was different from the one described in step E, the algorithm continued and steps E to H were repeated. The procedure stopped when there were no changes to the model (in terms of the significant variables included) between iterations.

Once the socio-demographic predictors for each LCA (i.e. lifestyle group) were finalised, then the predicted probabilities of being in an LCA for each socio-demographic factors were ran in STATA. This calculated the probability of being in a lifestyle group based on the category an individual is in for each socio-demographic predictor, holding the other predictors at their average values. These predicted probabilities were added to Figures 1 and 2, and described in the supplementary tables below.

Concordance in latent classes between within household members

Logistic regression models, which took account of clustered and stratified sample design, were estimated in sequential bivariate analyses to determine significant associations between the latent classes of individuals within a couple.

A5 References

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Table S.1 Observed-expected ratios of UKHLS mothers and their partners (2010/11)						
Risk Patterns	**Mothers**			**Partners**		
	Observed	Expected	O/E (95%CI)	Observed	Expected	O/E (95%CI)
	%	%		%	%	
No risk	4.5	2.9	1.5 (1.2, 1.8)	2.9	2.0	1.4 (1.1, 1.8)
F&V only	10.3	11.6	0.9 (0.8, 1.0)	11.7	12.4	1.0 (0.8, 1.1)
Physical activity risk only	9.8	9.9	1.0 (0.9, 1.1)	5.8	5.2	1.1 (0.9, 1.3)
Smoking risk only	0.3	0.7	0.4 (0.1, 0.7)	0.2	0.6	0.4 (0.1, 0.7)
Drinking risk only	1.5	0.8	1.8 (1.3, 2.4)	1.9	0.9	2.0 (1.4, 2.6)
F&V and physical activity risk	40.7	39.3	1.0 (1.0, 1.1)	33.7	32.3	1.0 (1.0, 1.1)
F&V and smoking risk	1.7	2.7	0.6 (0.4, 0.8)	2.7	3.9	0.7 (0.5, 0.9)
F&V and drinking risk	3.4	3.2	1.1 (0.8, 1.3)	5.6	5.8	1.0 (0.8, 1.1)
Physical activity and smoking risk	1.0	2.3	0.4 (0.3, 0.6)	0.7	1.6	0.4 (0.2, 0.6)
Physical activity and drinking risk	2.4	2.7	0.9 (0.7,1.1)	1.9	2.4	0.8 (0.6, 1.0)
Smoking and drinking risk	0.2	0.2	0.9 (0.1,1.8)	0.3	0.3	0.9 (0.2, 1.6)
F&V, physical activity and smoking risk	10.3	9.1	1.1 (1.0, 1.3)	10.4	10.1	1.0 (0.9, 1.1)
F&V, physical activity and drinking risk	8.8	10.8	0.8 (0.7, 0.9)	12.8	15.2	0.8 (0.8, 0.9)
F&V, smoking and drinking risk	1.0	0.7	1.3 (0.8, 1.8)	2.4	1.8	1.3 (1.0, 1.7)
Physical activity, smoking and drinking risk	0.7	0.6	1.1 (0.6, 1.6)	0.2	0.8	0.3 (0.0, 0.5)
All four risk behaviours	3.7	2.5	1.5 (1.2, 1.8)	7.0	4.7	1.5 (1.2, 1.7)
Unweighted Bases	*2538*			*2538*		
Weighted Bases	*2553*			*2553*		

Table S.2 The probability of partnered mothers with different socio-demographic characteristics being in a behavioural cluster

Socio-demographic and health characteristics	Never-smoked drinkers	Abstainers	Unhealthiest	Drinkers, ex-smokers	Unhealthy low freq drinkers	*Weighted n*
Overall probability % (95% CI)	27.8 (26.3, 29.3)	24.7 (23.3, 26.1)	10.6 (9.4, 11.7)	18.7 (17.3, 20.0)	18.2 (16.7, 19.6)	*3115*
Age group						
16-34	21.8 (19.1, 24.5)		12.8 (10.7, 14.8)	15.8 (13.4, 18.3)	21.4 (18.8, 23.9)	*1045*
35-44	29.1 (27.0, 31.4)		8.7 (7.2, 10.3)	20.1 (18.1, 22.2)	17.2 (15.2, 19.3)	*1477*
45-74	33.5 (29.9, 37.2)		10.5 (7.7, 13.3)	19.5 (16.2, 22.8)	14.0 (11.0, 17.1)	*595*
Marital status						
Cohabitees	20.5 (17.0, 23.9)	18.9 (16.0, 21.8)	14.3 (11.8, 16.8)		24.6 (21.2, 28.0)	*696*
Married or civil partnership	29.8 (28.0, 31.5)	26.5 (24.9, 30.4)	9.0 (7.7, 10.3)		15.7 (14.1, 17.3)	*2420*
Highest educational qualification						
Degree or higher (or equivalent)	34.2 (31.0, 37.4)		4.6 (2.9, 6.3)	21.6 (18.5, 24.6)	11.0 (8.3, 13.7)	*883*
Higher education or A level equivalent	30.2 (27.0, 33.4)		8.6 (6.4, 10.9)	18.9 (16.0, 21.8)	17.5 (14.6, 20.4)	*731*
O-level or equivalent	22.8 (20.0, 25.5)		13.1 (11.0, 15.3)	19.0 (16.3, 21.6)	21.2 (18.7, 23.8)	*952*
Other or none	21.4 (17.5, 25.3)		15.3 (12.0, 18.6)	12.3 (9.1, 15.3)	21.8 (18.2, 25.4)	*549*
Equivalised income quintiles (monthly)						
Top Quintile (>=£2675)	32.0 (28.7, 35.2)	21.8 (19.0, 24.5)	7.3 (4.8, 9.7)	22.4 (19.2, 25.6)	12.8 (9.8, 15.8)	*720*
2nd Quintile (>=£1767<£2675)	30.5 (27.4, 33.6)	23.6 (20.8, 26.4)	10.4 (8.1, 12.8)	19.1 (16.4, 21.9)	15.7 (12.8, 18.5)	*764*
3rd Quintile (>=£1266<£1767)	24.4 (21.1, 27.8)	26.8 (23.9, 29.7)	10.5 (8.2, 12.8)	19.3 (16.2, 22.4)	19.3 (16.3, 22.4)	*691*
4th Quintile (>=£884<£1266)	24.9 (20.9, 28.9)	27.6 (24.1, 31.1)	11.0 (8.4, 13.5)	15.0 (11.7, 18.2)	21.0 (17.7, 24.4)	*571*
Bottom Quintile (<£884)	20.6 (15.5, 25.6)	24.8 (20.9, 28.7)	14.5 (10.5, 18.4)	12.4 (8.6, 16.2)	23.4 (18.7, 28.1)	*370*
Economic activity						
In employment, self emp or govt training	29.8 (27.9, 31.6)	23.4 (21.8, 25.0)				*2151*
Unemployed or economically inactive	22.1 (19.1, 25.2)	27.7 (24.9, 30.4)				*964*
Ethnic group						
White	30.6 (28.9, 32.3)	16.5 (14.9, 18.0)	11.9 (10.5, 13.2)	20.7 (19.1, 22.2)	19.9 (18.3, 21.5)	*2675*
Mixed	20.6 (9.4, 31.8)	46.6 (30.7, 62.5)	7.1 (-1.9, 16.1)	23.5 (11.4, 35.5)	5.0 (-1.0, 11.0)	*33*
Indian, Pakistani, Bangladeshi, black African, Arab	7.7 (4.9, 10.5)	85.9 (81.0, 88.9)	0.4 (-0.3, 1.1)	1.1 (0.0, 2.2)	4.8 (2.7, 6.9)	*290*
Other	15.6 (10.2, 21.0)	58.0 (50.3, 65.6)	3.7 (0.5, 7.0)	9.7 (4.8, 14.7)	13.5 (8.0, 18.9)	*116*

Limiting longstanding illness			
Limiting LI	20.6 (16.7, 24.6)	27.1 (22.9, 31.3)	*395*
Non limiting LI, or no LI	28.8 (27.2, 30.4)	16.8 (15.3, 18.3)	*2721*

Table S.3 The probability of partners with different socio-demographic characteristics being in a behavioural cluster						
Socio-demographic and health characteristics	**Never-smoked drinkers**	**Abstainers**	**Unhealthiest**	**Drinkers, ex-smokers**	**Unhealthy low freq drinkers**	***Weighted n***
Overall probability % (95% CI)	29.2 (27.3, 31.0)	16.6 (15.1, 17.9)	12.2 (10.8, 13.6)	26.4 (24.5, 28.3)	15.8 (14.2, 17.3)	*2570*
Age group						
16-34	21.7 (17.9, 25.4)		15.7 (12.7, 18.7)			*689*
35-44	30.1 (27.5, 32.8)		10.8 (8.8, 12.9)			*1123*
45-74	33.9 (29.8, 38.1)		10.3 (7.9, 12.7)			*757*
Marital status						
Cohabitees	20.4 (16.3, 24.6)		15.7 (12.8, 18.6)			*570*
Married or civil partnership	31.4 (29.2, 33.5)		10.7 (9.1, 12.2)			*2000*
Highest educational qualification						
Degree or higher (or equivalent)	34.6 (30.7, 38.5)		3.6 (1.9, 5.3)	29.9 (26.1, 33.8)	12.2 (9.4, 15.1)	*739*
Higher education or A level equivalent	32.1 (27.6, 36.7)		10.0 (6.8, 13.1)	25.7 (21.6, 29.9)	16.6 (13.0, 20.1)	*456*
O-level or equivalent	26.7 (23.2, 30.2)		14.1 (11.4, 16.8)	27.1 (23.5, 30.6)	15.2 (12.4, 18.0)	*758*
Other or none	22.1 (18.2, 26.0)		18.7 (15.4, 22.1)	21.7 (17.8, 25.5)	18.9 (15.6, 22.2)	*615*
Equivalised income quintiles (monthly)						
Top Quintile (>=£2675)	34.9 (30.7, 39.1)	11.5 (8.6, 14.4)		28.9 (24.4, 33.4)	8.5 (5.5, 11.6)	*525*
2nd Quintile (>=£1767<£2675)	32.1 (28.4, 35.8)	14.2 (11.6, 16.8)		30.3 (26.4, 34.1)	11.5 (8.8, 14.2)	*643*
3rd Quintile (>=£1266<£1767)	24.1 (20.3, 27.8)	19.6 (16.3, 22.8)		26.6 (22.8, 30.4)	17.3 (14.1, 20.5)	*608*
4th Quintile (>=£884<£1266)	26.3 (21.8, 30.9)	19.1 (15.6, 22.6)		21.6 (17.4, 25.8)	21.1 (17.3, 24.9)	*491*
Bottom Quintile (<£884)	23.5 (16.9, 30.0)	19.1 (14.3, 23.9)		19.1 (13.6, 24.5)	22.7 (17.7, 27.7)	*303*
Economic activity						
In employment, self emp or govt training	30.3 (28.3, 32.2)		11.1 (9.6, 12.6)			*2248*
Unemployed or economically inactive	18.3 (12.8, 23.7)		17.8 (13.8, 21.9)			*322*
Ethnic group						
White	31.6 (29.5, 33.7)	11.8 (10.3, 13.3)	13.1 (11.6, 14.7)	28.1 (26.0, 30.2)		*2239*
Mixed	22.5 (9.5, 35.4)	23.7 (8.0, 39.5)	2.0 (-2.3, 6.3)	31.7 (13.6, 49.7)		*29*
Indian, Pakistani, Bangladeshi, black African, Arab	11.9 (8.2, 15.7)	53.4 (47.9, 58.9)	3.0 (1.0, 5.3)	9.6 (6.0, 13.1)		*231*
Other	14.7 (8.5, 21.0)	39.9 (30.0, 50.2)	5.7 (0.9, 10.5)	20.8 (12.6, 29.1)		*70*
Limiting longstanding illness						
Limiting LI					22.1 (17.2, 27.2)	*302*

Non limiting LI, or no LI	14.8 (13.2, 16.4)	*2268*

continued

Table S.3 The probability of partners with different socio-demographic characteristics being in a behavioural cluster						
Socio-demographic and health characteristics	**Never-smoked drinkers**	**Abstainers**	**Unhealthiest**	**Drinkers, ex-smokers**	**Unhealthy low freq drinkers**	***Weighted n***
continued						
Age of youngest child in household						
<5	31.0 (27.8, 34.0)					*1091*
≥5≤10	30.3 (26.9, 33.7)					*1038*
>10 years of age	24.7 (21.1, 28.4)					*433*
Number of children in household						
1				27.0 (24.1, 30.0)		*1278*
2				28.9 (25.9, 31.8)		*695*
3+				18.3 (14.0, 22.6)		*590*

Table S.4 Socio-demographic patterning of partnered mothers' latent classes: estimated odds ratios of belonging to a class

Socio-demographic and health characteristics	Never-smoked drinkers OR (95% CI)	Abstainers OR (95% CI)	Unhealthiest OR (95% CI)	Drinkers, ex-smokers OR (95% CI)	Unhealthy low freq drinkers OR (95% CI)	*Weighted n*
Age group (p-values derived from Wald tests)	(p<0.001)		(p=0.008)	(p=0.04)	(p=0.002)	
16-34	1		1	1	1	*1045*
35-44	1.53 (1.23, 1.90)		0.64 (0.48, 0.85)	1.35 (1.07, 1.71)	0.75 (0.59, 0.94)	*1477*
45-74	1.93 (1.49, 2.50)		0.79 (0.54, 1.14)	1.30 (0.96, 1.76)	0.57 (0.41, 0.80)	*595*
Marital status	(p<0.001)	(p<0.001)	(p<0.001)		(p<0.001)	
Cohabitees	1	1	1		1	*696*
Married or civil partnership	1.73 (1.35, 2.22)	1.81 (1.35, 2.42)	0.57 (0.43. 0.76)		0.54 (0.43, 0.69)	*2420*
Highest educational qualification	(p<0.001)		(p<0.001)	(p=0.002)	(p<0.001)	
Degree or higher (or equivalent)	1		1	1	1	*883*
Higher education or A level equivalent	0.81 (0.65, 1.02)		2.00 (1.21, 3.30)	0.84 (0.64, 1.11)	1.78 (1.26, 2.51)	*731*
O-level or equivalent	0.54 (0.42, 0.68)		3.25 (2.04, 5.18)	0.85 (0.64, 1.11)	2.30 (1.64, 3.24)	*952*
Other or none	0.49 (0.37, 0.67)		3.93 (2.38, 6.48)	0.50 (0.35, 0.71)	2.39 (1.64, 3.49)	*549*
Equivalised income quintiles (monthly)	(p=0.001)	(p=0.048)	(p=0.05)	(p=0.003)	(p=0.002)	
Top Quintile (>=£2675)	1	1	1	1	1	*720*
2nd Quintile (>=£1767<£2675)	0.93 (0.74, 1.16)	1.15 (0.85, 1.57)	1.52 (0.97, 2.38)	0.81 (0.63, 1.05)	1.28 (0.89, 1.84)	*764*
3rd Quintile (>=£1266<£1767)	0.66 (0.51, 0.86)	1.45 (1.08, 1.94)	1.53 (0.96, 2.44)	0.82 (0.61, 1.11)	1.68 (1.17, 2.43)	*691*
4th Quintile (>=£884<£1266)	0.68 (0.51, 0.91)	1.54 (1.11, 2.13)	1.64 (0.98, 2.64)	0.60 (0.43, 0.85)	1.89 (1.29, 2.75)	*571*
Bottom Quintile (<£884)	0.52 (0.35, 0.77)	1.26 (0.87, 1.84)	2.27 (1.34, 3.82)	0.48 (0.32, 0.73)	2.19 (1.42, 3.35)	*370*
Economic activity	(p<0.001)	(p=0.007)				
In employment, self emp or govt training	1	1				*2151*
Unemployed or economically inactive	0.64 (0.51, 0.80)	1.34 (1.09, 1.67)				*964*
Ethnic group	(p<0.001)	(p<0.001)	(p=0.001)	(p<0.001)	(p<0.001)	
White	1	1	1	1	1	*2675*
Mixed	0.56 (0.27, 1.18)	4.56 (2.34, 8.85)	0.55 (0.13, 2.27)	1.18 (0.59, 2.36)	0.19 (0.05, 0.72)	*33*
Indian, Pakistani, Bangladeshi, black African, Arab	0.17 (0.11, 0.26)	30.5 (22.2, 41.8)	0.03, (0.00, 0.18)	0.04 (0.02, 0.11)	0.19 (0.11, 0.30)	*290*
Other	0.39 (0.25, 0.61)	7.27 (5.19,10.2)	0.27 (0.11, 0.70)	0.41 (0.23, 0.73)	0.60 (0.36, 1.00)	*116*
Limiting long-standing illness	(p=0.001)				(p<0.001)	
Limiting LI	1				1	*395*
Non limiting LI, or no LI	1.64 (1.23, 2.17)				0.51 (0.39, 0.67)	*2721*

Table S.5 Socio-demographic patterning UKHLS (2010/11) partners' latent class: estimated odds ratios of belonging to a class						
Socio-demographic and health characteristics	**Never-smoked drinkers OR (95% CI)**	**Abstainers OR (95% CI)**	**Unhealthiest OR (95% CI)**	**Drinkers, ex-smokers OR (95% CI)**	**Unhealthy low freq drinkers OR (95% CI)**	***Weighted n***
Age group[a] (p-values derived from Wald tests)	(p=0.001)		(p=0.007)			
16-34	1		1			*689*
35-44	1.61 (1.22, 2.14)		0.63 (0.45, 0.88)			*1123*
45-74	1.96 (1.39, 2.75)		0.59 (0.40, 0.86)			*757*
Marital status[b]	(p<0.001)		(p=0.001)			
Cohabitees	1		1			*570*
Married or civil partnership	1.86 (1.38, 2.51)		0.62 (0.46, 0.83)			*2000*
Highest educational qualification	(p=0.001)		(p<0.001)	(p=0.039)	(p=0.039)	
Degree or higher (or equivalent)	1		1	1	1	*739*
Higher education or A level equivalent	0.89 (0.66, 1.18)		3.03 (1.64, 5.62)	0.81 (0.60, 1.07)	1.44 (0.99, 2.09)	*456*
O-level or equivalent	0.67 (0.51, 0.88)		4.57 (2.64, 7.89)	0.86 (0.66, 1.14)	1.29 (0.89, 1.86)	*758*
Other or none	0.51 (0.37, 0.70)		6.52 (3.85, 11.0)	0.64 (0.47, 0.87)	1.69 (1.17, 2.44)	*615*
Equivalised income quintiles (monthly)	(p=0.001)	(p=0.001)		(p=0.007)	(p<0.001)	
Top Quintile (>=£2675)	1	1		1	1	*525*
2nd Quintile (>=£1767<£2675)	0.87 (0.67, 1.13)	1.31 (0.88, 1.96)		1.07 (0.80, 1.43)	1.40 (0.87, 2.24)	*643*
3rd Quintile (>=£1266<£1767)	0.57 (0.42, 0.77)	2.04 (1.36, 3.05)		0.89 (0.66, 1.21)	2.26 (1.42, 3.60)	*608*
4th Quintile (>=£884<£1266)	0.64 (0.46, 0.90)	1.96 (1.29, 2.99)		0.67 (0.47, 0.95)	2.90 (1.81, 4.64)	*491*
Bottom Quintile (<£884)	0.55 (0.35, 0.86)	1.95 (0.96, 3.16)		0.57 (0.37, 0.88)	3.18 (1.94, 5.23)	*303*
Economic activity	(p=0.001)		(p=0.001)			
In employment, self emp or govt training	1		1			*2248*
Unemployed or economically inactive	0.49 (0.33, 0.73)		1.83 (1.29, 2.60)			*322*
Ethnic group	(p<0.001)	(p<0.001)	(p<0.001)	(p<0.001)		
White	1	1	1	1		*2239*
Mixed	0.60 (0.27, 1.36)	2.35 (0.96, 5.75)	0.13 (0.01, 1.14)	1.19 (0.50, 2.84)		*29*
Indian, Pakistani, Bangladeshi, black African, Arab	0.27 (0.18, 0.40)	8.86 (6.77, 11.6)	0.20 (0.09, 0.42)	0.26 (0.17, 0.40)		*231*
Other	0.35 (0.20, 0.60)	5.07 (3.19, 8.07)	0.38 (0.14, 0.97)	0.66 (0.39, 1.13)		*70*

continued

Table S.5 Socio-demographic patterning UKHLS (2010/11) partners' latent class: estimated odds ratios of belonging to a class						
Socio-demographic and health characteristics	**Never-smoked drinkers OR (95% CI)**	**Abstainers OR (95% CI)**	**Unhealthiest OR (95% CI)**	**Drinkers, ex-smokers OR (95% CI)**	**Unhealthy low freq drinkers OR (95% CI)**	***Weighted n***
continued						
Limiting long-standing illness					(p=0.002)	
Limiting LI					1	*302*
Non limiting LI, or no LI					0.60 (0.43, 0.83)	*2268*
Age of Youngest Child	(p=0.04)					
Under 5	1					*1091*
5-10	0.97 (0.75, 1.24)					*1038*
Over 10 years of age	0.71 (0.53, 0.95)					*433*
Children				(p=0.001)		
1				1		*1278*
2				1.10 (0.89, 1.36)		*695*
3+				0.60 (0.42, 0.84)		*590*

[a]Unlike the mothers analyses, no separate aged 16-24 category for partners was used since less than 2% partners were aged below 25 and but there was no single category for marital status

Table S.6 Percentage of partnered mothers in each lifestyle group by all socio-demographic characteristics						
Socio-demographic and health characteristics	**Never-smoked drinkers**	**Abstainers**	**Unhealthiest**	**Drinkers, ex-smokers**	**Unhealthy low freq drinkers**	
Overall %	27.8%	24.7%	10.6%	18.7%	18.2%	*100%*
Age group						
16-34	18.4%	28.0%	14.8%	14.7%	24.1%	*100%*
35-44	30.6%	24.4%	8.2%	20.6%	16.2%	*100%*
45-74	37.5%	19.9%	9.2%	20.9%	12.5%	*100%*
Marital status						
Si Cohabitees	17.2%	13.3%	20.1%	17.5%	32.0%	*100%*
Married or civil partnership	30.9%	28.0%	7.9%	19.0%	14.2%	*100%*
Highest educational qualification						
Degree or higher (or equivalent)	38.7%	26.8%	3.4%	23.1%	7.9%	*100%*
Higher education or A level equivalent	30.9%	24.6%	8.5%	19.0%	17.1%	*100%*
O-level or equivalent	21.2%	18.9%	15.8%	18.8%	25.3%	*100%*
Other or none	17.8%	31.9%	15.8%	10.8%	23.7%	*100%*
Equivalised income quintiles (monthly)						
Top Quintile (>=£2675)	40.4%	19.6%	5.0%	25.6%	9.3%	*100%*
2nd Quintile (>=£1767<£2675)	34.7%	21.4%	9.2%	20.5%	14.2%	*100%*
3rd Quintile (>=£1266<£1767)	22.7%	25.9%	11.8%	18.7%	20.9%	*100%*
4th Quintile (>=£884<£1266)	19.0%	29.2%	13.5%	13.2%	25.1%	*100%*
Bottom Quintile (<£884)	12.4%	32.5%	17.7%	9.8%	27.6%	*100%*
Economic activity						
In employment, self emp or govt training	32.8%	21.3%	9.7%	20.4%	15.8%	*100%*
Unemployed or economically inactive	16.7%	32.4%	12.5%	14.8%	23.5%	*100%*
Ethnic group						
White	30.7%	16.1%	12.1%	20.9%	20.2%	*100%*
Mixed	19.9%	44.7%	6.5%	24.0%	4.9%	*100%*
Indian, Pakistani, Bangladeshi, black African, Arab	6.9%	87.5%	0.4%	1.0%	4.3%	*100%*
Other	16.4%	60.6%	3%	9.3%	10.7%	*100%*
Limiting longstanding illness						
Limiting LI	18.5%	25.3%	12.4%	14.7%	29.1%	*100%*
Non limiting LI, or no LI	29.2%	24.7%	16.6%	10.3%	19.2%	*100%*

continued

Table S.6 Percentage of partnered mothers in each lifestyle group by all socio-demographic characteristics						
Socio-demographic and health characteristics	**Never-smoked drinkers**	**Abstainers**	**Unhealthiest**	**Drinkers, ex-smokers**	**Unhealthy low freq drinkers**	
continued						
Number of Children in the household						
1	28.9%	22.6%	11.9%	18.3%	18.2%	*100%*
2	28.1%	24.9%	9.0%	21.3%	16.8%	*100%*
3+	24.6%	29.5%	11.1%	13.7%	21.1%	*100%*
Age of youngest child in household						
<5	23.1%	27.6%	10.6%	18.8%	19.9%	*100%*
≥5≤10	32.7%	22.6%	9.9%	17.9%	17.0%	*100%*
>10 years of age	31.4%	21.6%	11.5%	19.3%	16.2%	*100%*

Table S.7 Percentage of partners in each lifestyle group by all socio-demographic characteristics

Socio-demographic and health characteristics	Never-smoked drinkers	Abstainers	Unhealthiest	Drinkers, ex-smokers	Unhealthy low freq drinkers	
Overall %	29.2%	16.5%	12.2%	26.3%	15.8%	*100%*
Age group						
16-34	19.5%	18.2%	18.7%	24.0%	19.6%	*100%*
35-44	32.0%	17.2%	9.8%	26.6%	14.4%	*100%*
45-74	33.8%	14.0%	9.7%	28.1%	14.4%	*100%*
Marital status						
Cohabitees	17.2%	13.3%	22.4%	28.0%	19.0%	*100%*
Married or civil partnership	32.6%	17.5%	9.2%	25.9%	14.8%	*100%*
Highest educational qualification						
Degree or higher (or equivalent)	39.9%	17.4%	2.7%	30.5%	9.5%	*100%*
Higher education or A level equivalent	32.9%	15.5%	9.2%	26.7%	15.7%	*100%*
O-level or equivalent	25.3%	14.9%	16.2%	27.4%	16.3%	*100%*
Other or none	18.4%	18.2%	20.8%	19.8%	22.7%	*100%*
Equivalised income quintiles (monthly)						
Top Quintile (>=£2675)	43.8%	10.2%	6.8%	31.9%	7.3%	*100%*
2nd Quintile (>=£1767<£2675)	35.6%	12.9%	8.4%	32.0%	11.0%	*100%*
3rd Quintile (>=£1266<£1767)	23.8%	19.1%	12.9%	26.6%	17.6%	*100%*
4th Quintile (>=£884<£1266)	21.6%	20.3%	15.6%	19.7%	22.8%	*100%*
Bottom Quintile (<£884)	13.2%	23.8%	22.5%	15.2%	25.4%	*100%*
Economic activity						
In employment, self emp or govt training	31.7%	16.0%	10.4%	27.8%	14.1%	*100%*
Unemployed or economically inactive	11.7%	20.2%	24.6%	16.2%	27.2%	*100%*
Ethnic group						
White	31.4%	11.7%	13.6%	28.3%	15.1%	*100%*
Mixed	24.2%	24.9%	1.8%	30.3%	18.9%	*100%*
Indian, Pakistani, Bangladeshi, black African, Arab	12.1%	55.5%	2.2%	8.6%	21.6%	*100%*
Other	15.9%	40.4%	4.4%	21.7%	17.6%	*100%*
Limiting longstanding illness						
Limiting LI	21.1%	18.5%	15.1%	19.4%	25.8%	*100%*
Non limiting LI, or no LI	30.3%	16.3%	11.8%	27.3%	14.4%	*100%*

continued

Table S.7 Percentage of partners in each lifestyle group by all socio-demographic characteristics						
Socio-demographic and health characteristics	**Never-smoked drinkers**	**Abstainers**	**Unhealthiest**	**Drinkers, ex-smokers**	**Unhealthy low freq drinkers**	
continued						
Number of Children in the household						
1	27.9%	14.8%	13.4%	27.6%	16.2%	*100%*
2	31.0%	16.1%	9.8%	29.3%	13.8%	*100%*
3+	27.9%	22.0%	14.8%	16.6%	18.8%	*100%*
Age of youngest child in household						
<5	27.3%	18.1%	12.7%	25.8%	16.2%	*100%*
≥5≤10	32.8%	15.5%	11.4%	25.6%	14.7%	*100%*
>10 years of age	29.1%	14.5%	12.0%	28.8%	15.6%	*100%*

MULTIPLE HEALTH BEHAVIOURS AMONG MOTHERS AND PARTNERS IN ENGLAND: CLUSTERING, SOCIAL PATTERNING AND INTRA-COUPLE CONCORDANCE

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